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JOURNAL OF MAMMALOGY

Vol. 12 NOVEMBER, 1931 No. 4

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Incorporated April 29, 1920

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The Journal of Mammalogy

Subscription rates, $4.00 per year; single numbers $1.00 each. Sent free to all members of the American Society of Mammalogists not in arrears for dues.

Subscriptions, changes of addresses, requests for missing numbers, applications for advertising rates, etc., should be sent to the corresponding secretary, Francis Harper, 206 Dickinson Ave., Swarthmore, Pa.

Manuscripts for publication, books and papers for notice and reviews, etc., should be sent to Edward A. Preble, U. S. Biological Survey, Washington, D. C.

Entered as second-class matter, November 22, 1919, at the Postoffice, Baltimore, Md., under the Act of March 3, 1879

Made in United States of America

JOURNAL OF MAMMALOGY

Published Quarterly by the American Society of Mammalogists

VOL. 12 NOVEMBER, 1931 No. 4

HABITS OF THE STAR-NOSED MOLE, CONDYLURA CRISTATA

BY WILLIAM JOHN HAMILTON JR.

[*Plate 13*]

The Star-nosed Mole has a wide distribution and is locally abundant, yet strangely enough very little in the literature of mammalogy deals with it. The following notes on habits, accumulated during the past six years, appear worthy of publication.

WEIGHTS

The average weight of thirty adult males taken throughout the year was 53.4 grams. The heaviest male weighed 70 grams, while the lightest, an old male with well worn teeth, weighed 39 grams.

The average weight of eighteen females was 50.3 grams. The heaviest weighed 77 grams, being the largest taken, while the smallest was 35.2 grams. During pregnancy it appears that the females may gain considerable weight. The average weight of twelve taken from December to February was 44 grams. During late March the specimens showed a decided increase in weight. A female, recently passed parturition in April, weighed 64.3 grams while a gravid female collected in early May, with tiny embryos, weighed 64 grams. The large 77 gram individual had six embryos, which combined could not have weighed more than a gram.

Six young of one litter, well furred and apparently able to shift for themselves, taken on May 17, 1927 averaged slightly less than 25 grams each.

RANGE AND NUMBER OF INDIVIDUALS

Without some method of marking and retrapping an individual a difficult problem arises when one attempts to determine the range of a small mammal. Seton (1909) is of the opinion that an acre is sufficient range for a single mole.

In a specimen that was taken 140 yards from the nearest water, an examination

of the stomach showed that this animal had last eaten some small crustaceans, *Hyalella knickerbockeri*, and a few dytiscid larvae. Both of these are aquatic. The mole may have travelled farther than this since feeding. Digestion had commenced, so presumably it had eaten an hour or more previously. Probably three times the distance this animal had gone is a conservative estimate of a day's travel for the mole.

In a swampy area near the head of Cayuga Lake, locally known as Renwick, about fifty moles have been taken in the past five years, without depleting their ranks to any appreciable degree. The area trapped covers about three acres. There are probably fifty moles living in this restricted community at the present time. In the same area they are outranked in number by *Blarina* and *Peromyscus*. Along the inlet to Cayuga Lake at Ithaca, New York, trappers take hundreds annually in their muskrat sets. Only a small pe.centage of these have been saved for the writer. One trapper told of taking over two hundred in a season, and added that they were as abundant as the muskrats. It is probable, from field observations and intensive collecting, that there must be an average of five pairs to the acre scattered through this area of swamp land that borders the lake for nearly a mile.

PERIOD OF ACTIVITY

The star-nosed mole is diurnal as well as nocturnal. This mole not infrequently comes above ground in the winter. Merriam (1884) captured several that were running about on the snow. Tenney (1871) and Wood (1922) both record activities of this creature on and just under the snow. A number of muskrat trappers have told of seeing this animal on the snow in the swamps about Ithaca. They also have seen the mole swimming under the ice.

While collecting specimens, the writer has frequently pressed in runways with his heel and noted the time of repair. Of 147 runways disturbed, 57 were repaired during the hours between 9 a.m. and 6 p.m., 29 were repaired between 6 p.m. and 8 a.m. and 61 were not repaired at all. On two occasions the burrows were repaired a few minutes after being disturbed.

DISPOSITION

These animals are gregarious and in some measure colonial. A small area will be dotted with their subterranean runways, and a short distance away, in an apparently similar habitat, not a sign of them will be evident. On May 25, 1928, three males were taken from a minnow trap in a small but swift stream. The trap was placed in a pool, in three feet of water. It seems likely that the animals were together when caught. On January 29, 1927, Fred Stevens, of Ithaca, presented me with a male and female mole that were taken from the same minnow trap. The female was not pregnant. This may indicate a tendency for companionship or possibly an early courtship prior to mating.

LOCOMOTION

Condylura is perhaps less fossorial than any other American mole with the possible exception of *Neürotrichus*. When the mole is on the surface, and wishes to dig in, the fore paws are closely pressed against the nose, palmar surfaces out. The hind feet are widespread, the toes spreading out at right angles to the body.

Rapid strokes of the fore feet, sometimes alternate but more often in unison, soon remove enough dirt to put the animal under cover. The nose is not used in digging. The movement of the fore limbs is aided by a twisting motion of the body, not unlike the actions of a swimming newt. When digging, the tentacles of the nose are brought together so as to close the external opening of the nostrils quite effectively.

The star-nosed mole is an excellent swimmer. The majority of the specimens examined in the flesh have been taken *under the water*. Practically all the winter specimens examined were taken on or near the bottom of a stream or lake. Most of the specimens were taken at the entrance to muskrat dens, in traps set for this rodent. Several trappers have told of taking these moles in the runways leading from the winter houses of the muskrats, and I believe that further study will show that they make the walls or the interiors of these houses not infrequently their homes.

I have many times watched these animals swimming, usually when captive. The fore limbs give rapid alternate strokes, which are the principle means of propulsion. The hind legs are kicked alternately. The tail plays only a minor part in propulsion, and is thrown slightly from side to side. A specimen I released in a small pool dove exceptionally well. The tentacles were closely pressed together.

RUNWAYS AND BURROWS

Once seen, the characteristic runways and mounds of this species can never be mistaken. In swampy ground they appear more like the work of a crayfish than that of a mole. The burrows vary in width from 1.3 to fully 3 inches. The height averages from 1.5 to 2 inches. In meadows the tunnels usually follow an undulating course, in a vertical plane. At intervals, which are rather irregular, the excess dirt is pushed out of these runways and accumulates to form the well known molehills. Merriam (1884) observed that the moles first prepared an opening for the excess dirt, then pushed the dirt, closely packed and molded to the form of the burrow, ahead of them. Freshly made mounds in wet ground show the characteristic lamellae, which indicates that their material has been powerfully constricted.

The tunnels in many instances open under water in the vicinity of a stream and not infrequently the burrows go so deep in swampy ground that the lower parts are well below the water line. In winter, the mole does not burrow as much as at other seasons but takes to the waterways. Then the runways lie close beneath the ice that border the streams and lakes. Advantage is likewise taken of fallen trees, logs and any large cover under which to thread their runways. It appears that progress is somewhat easier in such situations. The hills left by these moles are sometimes enormous, the largest ones being usually found in sandy rather than muddy soil. The largest measured, on a low lying athletic field, was 26 inches in diameter by 5¾ inches high. Like other moles, the star-nose does not throw out heaps of earth when burrowing near the surface. Short, blind pockets are often met with in the burrows.

The nests are invariably composed of dead leaves, straw and dead grasses, not shredded, and taken from the nearest available material. The nests are shaped as a depressed sphere, with only slight cover when the structure is beneath a log

or fallen tree. The nests built to receive the young are slightly more elaborate and considerably larger, yet always made from the material nearest at hand. From all that have been found and recorded, it seems that the mole exhibits great care in its selection of a site, making certain that the nest is well above the high water line by placing it in some natural elevation.

FOOD

In the course of food studies, 107 specimens, taken in every month of the year except July were examined. Not as greatly modified for digging through hard packed earth as other moles, the star-nose must take life a little easier, and exploit the muck beds and stream bottoms. It is small wonder that much of its food should be taken in such places. Fig. 1 shows the percentage by bulk of the various food items eaten by 107 moles. The large preponderance of aquatic organisms is quickly apparent. This same figure indicates that nearly fifty per cent of the food consists of annelids, but unlike the food of other moles, these are not principally earthworms. Reference to Fig. 3 will show that *four-fifths are of aquatic origin.*

Condylura feeds upon a large variety of insects, but a study of Fig. 2 shows that less than ten per cent of these are terrestrial forms, and the others are secured from the stream or creek bottom. It is true that the greater number of animals examined have been taken in the water, but large numbers have also been taken some little distance from streams. It seems likely that the moles, at least about Ithaca, New York, may make their winter headquarters nearer the streams because of the greater accessibility of food in such a region at this time of the year.

Among the annelids, aquatic oligochaetes seem to be favored. As many as 200 may sometimes be found in a stomach, together with a mass of dirt and mud. This would indicate that the mole must root along the bottom and of necessity take in a quantity of extraneous matter. Large numbers of leeches are frequently taken. Some as long as two inches are bitten through in several places but are often swallowed entire. The genus most frequently eaten appears to be *Placobdella.*

Second in importance to the annelids appear to be insects, which make up about one third of the bulk of the stomachs. Fig. 2 shows the approximate ratio of the various insect groups that seem to be eaten most frequently by this species. A small portion only consists of those forms derived from a terrestrial habitat. In the specimens that are captured in the water, Dytiscid larvae, while not equalling in bulk the caddis worms, were found in more stomachs, and it is presumed that this beetle larva is perhaps a more important article of diet than the trichopterids. Midge larvae, like the small oligochaetes, are literally raked in from the mud, and much sediment accompanies any number of these when present in the stomach of the mole. The larvae of crane flies are also taken frequently, but these may occur in decaying vegetation and swampy ground as well as in the water.

Crustacea are taken sparingly, but probably only because of their minute size. The little shrimps of the genus *Gammarus* and *Hyalella* have been found not infrequently in the examinations. Mollusks were found in very few stomachs. They are probably eaten more frequently than analysis shows. A captive specimen took slugs, *Agriolimax*, with evident relish.

In a single stomach the remains of a small minnow were found. It may have

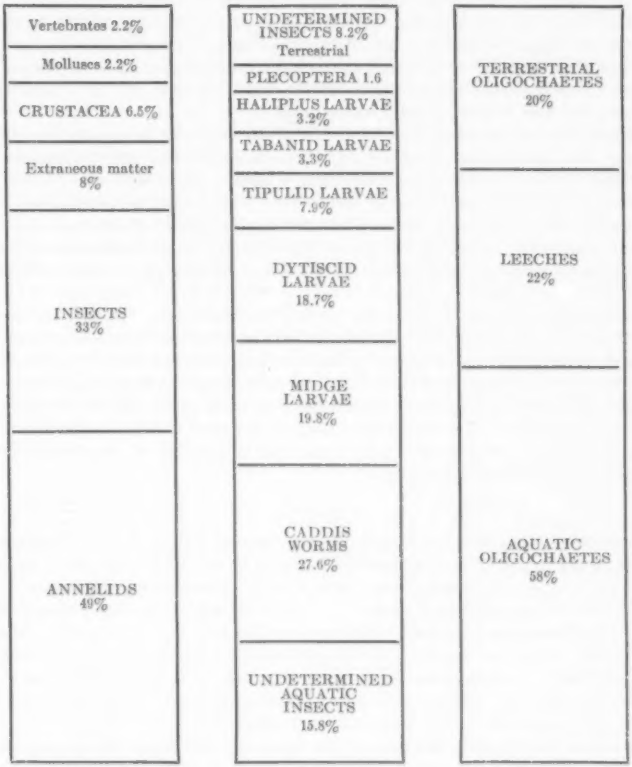


FIG. 1 FIG. 2 FIG. 3

FIG. 1. Relative percentages in bulk of different food items taken from 107 *Condylura* throughout the year

FIG. 2. Relative percentages in bulk of the various insects eaten throughout the year, but principally the winter months.

FIG. 3. Relative proportions of various annelids consumed. The terrestrial forms, usually large specimens of *Lumbricus*, constitute only one-fifth of the annelids in the stomachs that were examined.

been found dead. The star-nosed mole is undoubtedly agile enough to capture these smaller fish.

The observations on the food of this species are in no wise conclusive. Many writers are in accord with the statement that moles feed to a rather important extent on vegetable matter. In all the specimens of *Condylura* examined, not enough plant remains were found to justify the conclusion that the animal had taken them intentionally to round out its diet. To date, we must tentatively believe that this mole is strictly carnivorous.

When feeding, the forepaws materially assist the mole in holding the food in place. The backs of the palms are slightly elevated from the substratum and hold the food firmly in position while the animal feeds. The snout and all the tentacles are immersed while the animal drinks. They may be kept under water for five or six seconds at a time. The tentacles are firmly drawn together while the animal feeds. These tentacles are in constant motion when the animal is searching for food, with the exception of the two median upper ones. These are held rigidly forward.

A captive *Condylura* ate sparingly of many natural foods. This animal was fed small amounts to determine if it could subsist on less than the enormous amount that all writers regard as a necessity for maintenance in the mole. Over a period of 48 hours only 12 grams of food was fed a mole weighing 45 grams, or less than 14 per cent of the animal's body weight per day. The mole could not live long on such a scanty diet, and it died a day later, after a meal of several worms. I suspect that further experiments will prove that one-fourth of the weight of the animal is ample for a day's feed.

ENEMIES

Parasites: *Condylura* is a host for many external parasites, as well as numerous internal forms. Captive specimens appear to be much annoyed by troublesome arthropods, and much of their time is spent in scratching themselves.

Mites of the genus *Androlaelaps* are among the most abundant external parasites. Siphonaptera have been taken from half the specimens examined. Thanks are due Dr. M. A. Stewart for determining these. *Ctenophthalmus wenmanni* and *Ctenophthalmus pseudagyrtes* have been collected from the moles frequently. Less often they are afflicted with *Ceratophyllus wickhami*. Internally cestodes are occasionally found, but nematodes are often abundant. Ascarids are very common on the stomach, the walls of the intestine, just under the integument of the rump and shoulder region, and imbedded in the mesenchyme. They are probably the same species as is found so commonly in shrews when one is skinning these animals. The worms are enclosed in a tissue sheath and are invariably coiled. They are 3 to 4 mm. in diameter when coiled and average 35 mm. when extended. There may be as many as a hundred in one host.

Predatory Animals: While the writer has no evidence that fish prey upon this animal, it does not appear unlikely that this sometimes happens. The aquatic habitat selected by this mole is also the home of large bass, pike, and other foragers.

Raptorial birds feed on the mole. The writer has examined the stomachs of red-tailed hawks and great-horned owls, both of which contained *Condylura* remains. Pellets of a screech owl that was under observation during an entire

winter produced three mole skulls. Barn owl pellets show *Condylura* remains. A skunk killed in February had eaten a star-nosed mole.

REPRODUCTION

The season of reproduction for *Condylura*, as in other moles, is in the spring. Litters of young from central New York have been recorded from April 18th until the middle of June. The majority of young appear to be born about the end of the first week in May, but there is a wide deviation from this date. There seems to be only one litter a season.

About Ithaca, New York, sexual activity on the part of the males commences in late January. Prior to this the testes are small and not descended. During early February the sexual organs commence to increase in size and by the time they have reached their full development, from the middle of March until May, they are enormous. (Plate 13.) In a 54 gram male, taken in March, the combined weight of the testes was 4.8 grams. This is equal to 8.8 per cent of the body weight. This great enlargement of the male generative organs is marked by a corresponding increase in size of Cowper's glands. These bulbo-urethral glands, which discharge their secretion into the urethra near the base of the urinary bladder, measure 18 x 11 mm. in an individual with greatly enlarged testes.

The development of the embryos in the latitude of central New York may be found from late March into early June.

Development of Embryos of Condylura at Ithaca, N. Y.

DATE	NUMBER	DEVELOPMENT
March 29	6	Early, 4 mm. each, crown-rump.
April 3	6	Late, 16 mm. crown-rump, 2/3 time.
April 7	7	Early, 4–6 mm. crown-rump.
April 16	6	Early, probably several days.
April 18	?	Just given birth to young.
April 22	6	Early, 2 mm. each.
May 17	7	Early, 1 mm. each.
May 18	6	Early, 3 mm. each.
June 10	?	No. 5026. C. U. Mus. Female with embryos. No other data.

As to the permanence of mating, observations carried on in the field would suggest that these animals pair in the fall and remain together until the breeding season, when the male, perhaps under pressure, leaves his mate. The pair taken in a minnow trap on January 26 may or may not have been mates, and several instances where pairs have been taken, perhaps mated, on successive nights from the same burrow, would further bear out such testimony. Observations are fragmentary here, however.

Few accounts of nests of this species appear in the literature. Jackson (1915) lists one from Georgetown, District of Columbia, found by Morris M. Green, and containing five young about one-third grown. These were collected from a nest under a log on the flats of the Potomac River, on May 22, 1888. Two of the young

from this family are slightly more developed than the others, but it was not known whether this was due to difference in age or to some other cause.

Bishop (1902) describes a nest of this species containing four young. He says: "On May 22, 1890, while having some apple trees planted I had the good fortune to find a nest containing four young. . . . . The particular spot where the nest was found was a little hillock or cradle hill which had been formed apparently by a tree having been blown down. When the roots had rotted away a small dry mound of black sedimentary earth was formed, and in this the nest was built. The mound was high enough to be out of the way of storm water during wet weather.

"The excavation bearing the nest was ten inches below the surface, and was made in a circular form, seven inches in diameter. The nest was built of old dry grass, and was very compact and neatly made. Although the mound contained a complete network of roadways, no earth was thrown to the surface within ten feet of the nest.

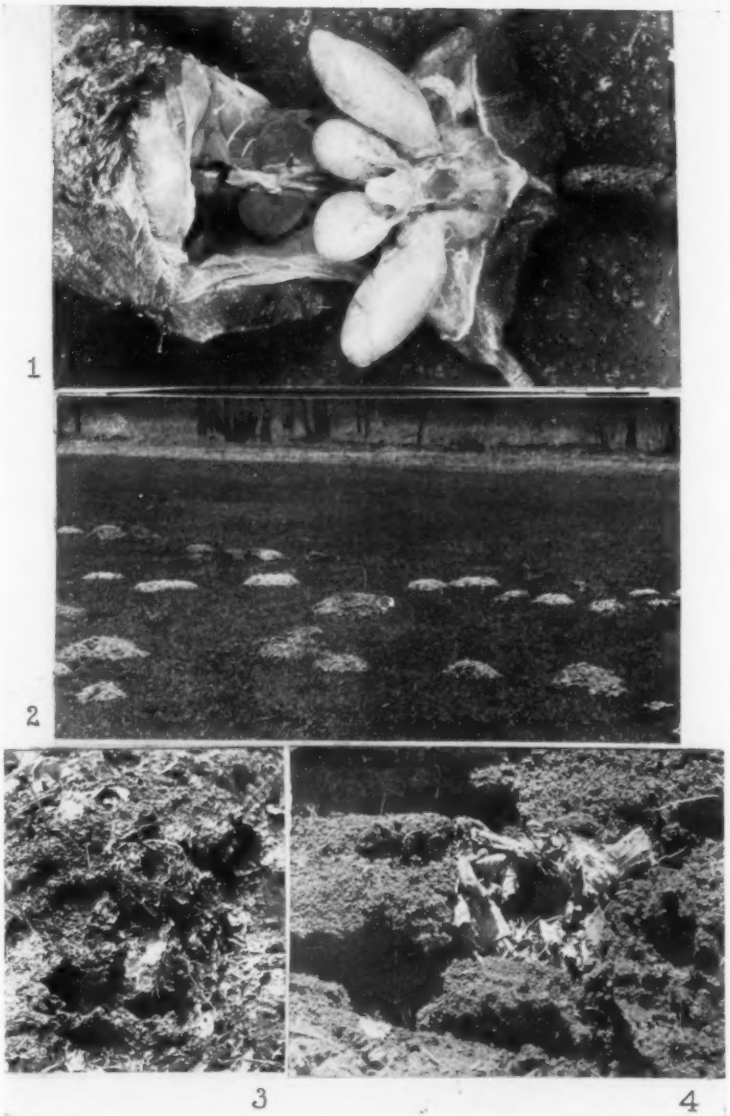
"The young were probably ten days old, the fur just beginning to start, which gave the skin a dark brown color."

Rhoads (1897) lists a female and four nearly mature young taken in the same trap on successive nights in the underground passageways of a spring.

Audubon and Bachman (1851, vol. 2, p. 142) described a nest that they believed belonged to this species but which was undoubtedly the nest of a common mole (*Scalopus*). The very fact that the radiations could not instantly be made out on the nose of the post-embryonic young would be in itself sufficient evidence to prove they were not the young of the star-nosed mole. These nasal rays appear early in development and may be seen in young of half time embryonic development.

Harper (1927) records a nest of this species in southern Georgia containing young above the water in the stump of a bay tree. Simpson (1923) found the nest of *Condylura* in a manure pile at Ithaca, New York, on May 23, containing five young about ten days old. Kennard (1929) reports finding a nest of this species in the middle of a compost heap on April 25, in Massachusetts, in which only three young were present. The young, of unknown age and measuring 80 mm. in length over all, including the 20 mm. tail, were hairless, with gray backs, shading into pink on the belly.

No young have been seen at birth, and the earliest as well as the smallest examined were killed by a dog, which dug them from their nest in a barnyard manure pile. This was in late April. They are pale pink, and no hair is visible. In a young specimen collected from the nest, supposedly ten days old, the dorsum is finely covered with hair. On the belly this hair is considerably shorter and lighter in texture, as is also the skin of this region. The tactile vibrissae of the snout and the margins of the fore feet are well developed. The eye appears as a small elevated slit, with no visible opening. A wrinkled slit represents the external ear, and appears to be placed just above the proximal end of the forearm. Midway between the eyes and the anterior margin of the ear there are two tactile hairs. Their use is probably of a sensory nature. The feet are well developed and have taken on the scaled appearance of the adult. The external genitals are clearly defined and even at this early age the sex may readily be determined by a careful macroscopic examination.



EXPLANATION OF PLATE

FIG. 1. Genitalia of male *Condylura*, to show enormous enlargement of testes and Cowper's glands. Natural size. March 18, 1930. Ithaca, N. Y.

FIG. 2. Mole hills of *Condylura* in sandy soil at Stewart Park, Ithaca, N. Y. March 28, 1927.

FIG. 3. Nest of *Condylura*, with runways. Renwick, Ithaca, N. Y. May 7, 1927.

FIG. 4. Nest of *Condylura*, with adjoining runways. The nest was under a log. Renwick, Ithaca, N. Y. April 27, 1930.

In a series of young that have not left the nest but are well furred, the pelage is considerably darker and shorter than that of the adults. This short, almost cropped appearance of the nestlings is characteristic of the young of the year. Like shrews, these moles grow very rapidly in the first few weeks of life and are quite able to shift for themselves when the nest is vacated. Two litters of young, well furred and able to run from the surroundings of the nest when disturbed, were still nursing. Usually the nest is situated in such a position that available food is close at hand. This is particularly true when the home is situated in a compost heap or manure pile, as is frequently the case.

SENSES

The eyes of the mole probably serve to distinguish light from darkness and nothing more. While all the elements of the normal eye are present, they are in such a condition of crowding due to the great reduction in size of the eyeball, that it would be impossible for them to function in a normal manner. In captive specimens of *Condylura*, the hair about the eye is parted at all times. The minute eyeball externally measures only 0.9 mm. in diameter. It probably functions better in this species than in other moles, as the star-nose spends more time on the surface of the ground than do the other forms.

The sense of smell does not appear to be developed to more than a slight degree. When food was placed within a few inches of them, the captives would not respond immediately, even though food had not been proffered for some time.

Hearing appears to be more acute in this mole than in others. Herrick (1892) is of the opinion that hearing is acute. The external ears of *Condylura* are remarkably large, although destitute of a projecting auricle. *Scalopus* has neither an auricle nor a meatus externus opening on the side of the head, as the skin of the head in this genus is drawn tightly over the funnel. This leaves a slight ring-like expansion of the skin, which rises a bit above the general surface. Perhaps the larger ear of the star-nose is due to the animal's more frequent wanderings on the surface. Lacking in good eyesight, it is highly probable that the star-nose must rely to a greater extent on the sense of hearing than other moles, particularly those that are more strictly fossorial.

To compensate for the poor development of the other senses, touch is remarkably well developed. This sense consists primarily of certain tactile hairs and end organs which are richly supplied with nerves. Ayers (1885) made a histological study of the snout in *Condylura*, and found that tactile papillae are not generally distributed over the ends of the nose but are confined, for the most part, to the flexible finger-shaped processes. The papillae appear, under a low magnification, as uniformly rounded prominences disposed in more or less regular rows, extending in the direction of the long axis of the ray. The mole has specialized tactile hairs on the manus. Kazzander (1909) studied these tactile hairs and describes their arrangement. Some of them he considers tactile in function while others are not. In *Condylura* these hairs and those of the snout are the first to make their appearance in the young mole. In the adult, the tactile hairs number about one hundred on the manus, and are evenly distributed around the margin. They are longer and perhaps better developed on the inner border of the hand and possibly more sensory, inasmuch as this part would be in closer contact with the ground.

This tactile sense, so highly developed in the mole, is just what we should expect in such a specialized fossorial type. The degenerate eyes, the small ear opening, and the lack of a projecting auricle, with the consequent crowding of the sensory hairs toward the anterior end of the animal, are all in keeping with its habits.

PERIODIC ENLARGEMENT OF THE TAIL

There is a remarkable swelling of the tail in this species that occurs during the winter and spring months. In both sexes this appendage may at this time become enormously enlarged and somewhat flattened. This swelling, in some individuals, may commence as early as the last week of October and persist until June.

Of thirty males examined in the flesh, taken between December 4 and June 3, nineteen had enlarged tails and eleven had normal tails. Of the nineteen, eight had moderately enlarged tails while eleven had greatly swollen tails. The largest tail measured 14 mm. in diameter through the thickest part. For comparison, the diameter of a ten cent piece is 18 mm.

Of sixteen females that were examined during the same period twelve had enlarged tails, half of which were moderately enlarged and the rest greatly swollen. Three January specimens and a February individual had normal tails.

When the tail is greatly swollen the scales covering this organ are pulled apart, the flesh shows through and a decided pinkish tinge is given to the skin of the tail. This swelling, when reaching its peak, may be accompanied by a greasy secretion, which gives the tail the appearance of having been rubbed in fat. There seems to be no peak for this enlargement. Indeed, adults of like or opposite sex may be taken on the same day, one of which will exhibit a remarkable enlargement whereas the other will be quite normal.

A captive specimen taken on March 16 underwent a decided change in the size of the tail during the two days in captivity. When first taken, the tail was fat and enlarged, but on the 18th, after feeding to a limited extent, the tail had become very noticeably shrunken and the skin about it, which had been tight and firm when first noticed, was loose and wrinkled. It is not suggested that, in the absence of sufficient food, some reserve nutriment was drawn from this area and thus caused the loss. As has previously been stated, food is rather easily secured in the winter and it does not seem likely, for this reason, that the enlargement is due to storage and that the tail acts as a reservoir. The periodic increase in size of the tail is an enigma that does not appear to be easily solved.

ECONOMIC IMPORTANCE

It seems that *Condylura*, unlike *Scalopus* and *Scapanus*, will never become injurious enough to warrant wholesale destruction. Several cases are known where the mole has disfigured lawns on the low-lying flats about Ithaca, New York. At Stewart Park, during the spring of 1927, the mounds became very numerous and unsightly over a good portion of the playground.

By its very nature, however, the habitat in which this mole thrives keeps it from the notice of the agriculturist, and seldom if ever is a complaint heard from this source. *Condylura* is one of the most peculiar mammals that we can boast of in a land filled with interesting forms.

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NOTES ON SMALL MAMMALS OF UTAH

By J. S. Stanford

The following paper is based principally on a study of 375 or more mammals collected by the writer (except when otherwise stated) in Sevier, Wayne, Garfield, Salt Lake, Cache, Morgan and Boxelder counties from 1928 to 1930. One hundred and forty skins were made, besides a number of alcoholics. These skins and specimens are in the Utah State Agric. College Museum; the writer's collection at Logan; the University of Utah; and three *Microtus* in the University of California.

Collecting began at Salina, Sevier Co. in September, 1928 and was continued in that region until the next August. Salina lies in the rich agricultural Sevier Valley (elevation, 5160 ft.), with low hills on the south and east. Salina Canyon extends for some twenty miles eastward into the rugged Wasatch Mts. Eight miles from Salina, Gooseberry Creek enters Salina Canyon from the south and in an area of several square miles adjoining this creek are farms. On one of these farms belonging to Mr. J. O. Ivie and in this general region considerable collecting and observing was done from October to August.

Pinyon pines, Utah junipers, shadscale and rabbit brush are characteristic trees and shrubs in the valley and are found also in the lower Gooseberry region, with a mixture of sagebrush. Several miles south, on Gooseberry Creek, at an elevation of 7800 ft., is the Government Experiment Station for the study of poisonous range plants. Aspens and sagebrush dominate in this region of many flowers and creatures. It is a fairyland in early July, in contrast with the lower, hotter, drier valley. Douglas fir, balsam fir, spruces, etc. are found on the higher ridges and slopes.

In September, 1929, a party from the University of Utah, consisting of Dr. R. V. Chamberlin, three members of his staff (including the writer), and three advanced students motored to the Henry Mts. in eastern Garfield Co. Frequent stops were made along the way to collect vertebrates, mollusks, arachnids, insects, and plants. Three days were spent at Fish Lake (elevation, 8000 ft.) where many specimens were collected, and two days at Lyman, collecting on and around Mr. Neff's ranch, which is near the Thousand Lake Mountain.

Mr. King's ranch, at the western base of the Henry Mts. was reached after exciting and tiring adventures with quicksand, mud and washouts caused by heavy rains which delayed us an extra day at Lyman. At

the ranch we met interesting cowboys and trappers who generously provided us with shelter and transportation in the shape of frisky horses and old, wise, sure-footed mules. The latter no doubt enjoyed the trips, refusing to be hurried, when carrying some of the scientists new to the riding game. Shooting from the back of one mule caused him no concern and a number of birds were taken in this manner that would have flown before one could dismount.

As one ascended the trail, pinyon pines and junipers were left behind, replaced by sagebrush and a belt of magnificent yellow pines, and on up into Douglas firs, limber pines, and aspens, and near the top on a north slope a grove of Colorado blue spruce and balsam fir.

Many sheep, cattle, and deer graze on the rich upland pastures; bird and insect life is abundant, and doubtless also mammals, but very few were seen. We regretted that our plans could not include some days and nights to spend in this oasis, surrounded by crimson, purple and golden deserts with a faint line of blue to the southeast marking the Colorado River.

On the return trip some collecting was done during an over-night stop at Fruita, and a half day spent on a side trip to a large natural bridge. Under this bridge the writer took a chipmunk new to him.

In Cache County, principally in Logan (elevation, 4500–4700 ft.) and Logan Canyon up to 7000 feet, and in Boxelder County, the writer collected birds and small mammals during the summer and autumn of 1930.

The writer desires to thank Dr. R. V. Chamberlin for assistance and suggestions given and Dr. Joseph Grinnell and staff members of the Museum of Vertebrate Zoölogy and the U. S. Biological Survey for their identification of many specimens.

Marmota flaviventris nosophora Howell.
Marmota flaviventris engelhardti Allen.—Woodchucks were seen at the Experiment Station, Fish Lake, Salt Lake City (foothills), and in Logan Canyon. Eight were secured and five skins made. At the Experiment Station (below which none was seen) woodchucks were plentiful and tame in a pasture by the station, but wild along the road and on the high ridges. Five were easily taken with a .410 gauge shot gun in a clump of aspens growing among large boulders in the pasture. Two skins were made, both of males. Three females were shot in September by the writer and Mr. Durrant among boulders shaded by aspens at Fish Lake. The skins of these three animals vary in color, especially on the lower parts, two being quite gray and one reddish. The two skins of the males are intermediate in color.

Otospermophilus grammurus utah (Merriam).—Rock squirrels are common in Salina and on up to the Experiment Station. They were seen also in Salt

Lake City (foothills), in the pinyon pine zone in the Henry Mts. and in Logan and Logan Canyon. Seven specimens were secured, all from the Salina region, and three skins made.

These inquisitive, wary rodents were seen in the fields and canyons in the autumn and again on March 16, and on through the summer. On May 1, I secured a large male in Salina Canyon by knocking it with a stone from the lower limbs of a poplar. A male and female were trapped in mid-May at the same burrow in an alfalfa field in Salina. One was shot on Gooseberry Creek and one about 15 miles from Salina, in the canyon.

The skin taken on May 1 shows the molt in progress, the rump and flanks being streaked with gray and rufous, with the hair shorter than on the adjoining mottled gray areas. The skin of the female taken in mid-May has a large grayish-rufous patch on the rump and back.

Callospermophilus lateralis lateralis (Say).—Golden chipmunks are conspicuous in color and habits, hence are soon seen where present. We found them quite abundant at the Experiment Station late in July and took ten adults and immature animals. Only one was seen in the lower Gooseberry region. It lay on a ledge near the Ivie farm and was easily taken. One was shot at Fish Lake in September. Twelve were taken and five skins made.

Callospermophilus castanurus (Merriam).—Two or three were seen among the rocks and sagebrush at the head of Logan Canyon, July 19, 1930. One beautiful large male was shot as it sat upright on a boulder watching us.

Citellus mollis mollis (Kennicott).—This small ground squirrel is abundant in the fields, along the roads, and among the lower hills and canyons in Sevier Valley. Fifty-six were shot and trapped in and around Salina (mainly for the ectoparasites) and three skins made. Not one was seen late in September, although their numerous burrows were much in evidence. On March 16, a number were seen in Salina Canyon. Invariably, every animal ran to its burrow and paused at the entrance until I rode by, or if approached too closely it darted down its hole, emitting a series of high-pitched notes. They were most abundant during April and May, especially on the dumping grounds east of town. On June 5, I trapped a very fat adult; by July 20, most of these rodents had disappeared for their long sleep. Considerable damage is done to crops grown in fields on the borders of the valley adjoining the foothills.

Citellus armatus (Kennicott).—This ground squirrel was collected in Sevier, Salt Lake, and Cache counties. Many were seen in Boxelder County. Thirty-two were shot and trapped and fifteen skins made; three from Sevier, one from Salt Lake, and eleven from Cache County. The species was seen in Sevier County only at the Experiment Station and at the head of Salina Canyon. Here on a grassy flat by the highway they were numerous and ten were shot on August 2. Those skinned were very fat.

Driving into Cache Valley, June 12, 1930, we saw numbers along the roads (some killed by autos) and in the fields where they do much damage. Fourteen ground squirrels were trapped and shot in the fields during June and July and many times as many could have been secured. They were abundant at the head of Logan Canyon, July 19. Their mounds and those made by the pocket gophers were numerous on the grassy flats in the canyon bottoms. They avoided our traps set out one morning, and only two were shot. Ground squirrels taken in

July in the valley were very fat. By about August 10, all had vanished for the winter.

Ammospermophilus leucurus leucurus (Merriam).—This antelope squirrel was taken only in Sevier County. Three were collected in the foot hills at Monroe and one in the low hills at Salina. Several others were seen in and near Salina Canyon. This pretty little rodent is not abundant in this region, yet it could be found by hunting for it among the lower hills.

Ammospermophilus leucurus cinnamomeus (Merriam).—One female was taken on Neff's ranch near a brush fence at Lyman. On King's ranch in the Henry Mts., where this species was common, seven were trapped and shot. Another was shot among the pinyon pines in the Henry Mts. The ranchers call them chipmunks. Four skins were made. The King's ranch skins are more rufous than the skin taken at Lyman.

Cynomys parvidens Allen.—Utah prairie dogs were seen only in Sevier County. Two were taken on the Ivie farm and three at the head of Salina Canyon.

These "mound builders" are common on the farms and grassy flats in the Gooseberry region, where they do considerable damage to crops. They are easily poisoned in the spring when they emerge hungry from their holes. In Salina Canyon, on a grass covered flat by the river, we found a large colony of inquisitive "dogs," in spite of the highway adjoining the "town." Were they ever shot at? We proceeded to do so and soon found that a mortal wound, rendering movement impossible, was necessary to prevent their escaping into the burrows in their death struggles. When the effect of their teeth on shoe leather has been noted, one hesitates to thrust an arm down a hole in the hope that the victim is within reach.

Eutamias minimus consobrinus (Allen).—The Wasatch chipmunk was taken in Sevier County at the Experiment Station, on the Ivie farm, at the head of Salina Canyon, and at Fish Lake; also in Cache Co. A chipmunk with orange sides, possibly this species, was seen near Mt. Ellen in the Henry Mts. A shot from the back of a climbing mule went astray and the chipmunk vanished in the brush. Thirty one specimens were taken and 12 skins made of adults and immature animals.

On the Ivie farm chipmunks were taken in the autumn and the following spring. They were common at the Experiment Station in July. None was seen in Salina Canyon below the entrance of Gooseberry Creek. At Fish Lake in September we saw many of these little rodents feeding on the camp garbage dumped some distance from the cabins. Running quickly to cover when we approached, they soon returned to feed on the rich morsels. Brewer blackbirds and green-tailed towhees were also feeding there and the three species made an interesting group. Nine chipmunks were shot at Fish Lake, most of them at the garbage piles.

Several were seen and one taken at head of Logan Canyon in July. Many chipmunks, doubtless this species, were seen in this canyon down to the entrance.

Eutamias quadrivittatus hopiensis Merriam.—At Fruita, September 14, we fortunately secured two Hopi chipmunks. Two or three others were seen. Their light colors blend well with the light sandstones of that region.

Eutamias umbrinus (Allen).—A female Uinta chipmunk was shot in the thick brush in Spring Hollow, a tributary of lower Logan Canyon, July 15, 1930. Several berry seeds were found in its pouches.

Thomomys perpallidus aureus Allen.—Four of these golden-yellow tunnel

makers were taken in Sevier County, two on the Ivie farm and two in Salina, drowned out of their tunnels in an alfalfa field. On November 14, an adult was captured in a special gopher trap about an hour after the trap was set in the entrance of a burrow in a potato patch. An immature gopher was trapped, January 1, by a straw stack, where it had made extensive tunnels in the unfrozen ground protected by the straw. They are quite numerous on the Ivie farm, the lines of tunnels marked by mounds being much in evidence.

Thomomys uinta.—We found numerous mounds in the loam of the bottoms at the head of Logan Canyon where we camped. Early next morning we were astonished to see earth in motion on some of the mounds. Presently heads and bodies of gophers appeared as they pushed out the loads of earth. Several shots at them with the .22 rifle failed. In desperation the .410 gun was lined on a hole and when the gopher appeared it was blown out of the burrow and mangled almost beyond recognition. Fragments of skull and skin were saved.

Dipodomys ordii longipes Merriam.—On King's ranch, Mr. Newby, one of the collecting party, secured three kangaroo rats. One, an immature specimen, was captured alive and caged but it died on our return trip. Numerous mounds with several entrances in each were seen along the road between King's ranch and Notum.

Onychomys leucogaster brevicaudus Merriam.—Only one specimen was taken, caught in a mouse trap set at the entrance of a small hole on the foothills south of Salina, Jan. 14, 1929.

Reithrodontomys megalotis megalotis (Baird).—Four harvest mice were trapped in Salina in mid-November by setting traps in runways in a small dry meadow of wire grass and sedges. One was taken, also, June 30, in the brush by a canal in Logan.

Peromyscus maniculatus rufinus (Merriam).—At first one is surprised at the abundance of these attractive little rodents which seem to be everywhere and yet are so seldom seen alive. Traps set in ledges, at entrances of burrows, by fences, or in buildings caught these mice. A few were taken alive in cage traps and one alive, held by tail, in the choke trap. Four or five were killed with a fork in a dry alfalfa field west of Salina. One was found in a steel trap, dead and covered with wet slime. Snake tracks in the dust confirmed our suspicions that the mouse, which was too big to be swallowed, was disengorged.

About 50 specimens of the two subspecies were taken; 8 skins of *P. m. rufinus* were saved: Salina, 3; Fish Lake, 4; Lyman, 1.

Peromyscus maniculatus sonoriensis (LeConte).—Seven skins of this sub-species were taken: Lyman, 1; Logan and canyon, 6.

Peromyscus truei truei (Shufeldt).—Three or more big-eared rock mice were trapped near Salina, among the ledges inhabited also by desert wood rats. Two skins were made.

Neotoma desertorum Merriam.—Desert wood rats were trapped from October 1928 to September 1929 around Salina, in the canyon, and in the Gooseberry Creek region; and on King's ranch in the Henry Mts. Their vertical range is probably not great, at least in Sevier County. None was trapped at the Experiment Station nor at Fish Lake. Twenty-four were taken and eight skins made.

Wood rats, like other nocturnal animals, may be quite abundant and yet rarely seen. However, rat signs, such as piles of sticks, bones, prickly pears, etc., among

the ledges cannot be missed by the most casual observer. Only one rat was seen alive and free. This wood rat had built a snug nest of packing under a car body on the dumping grounds east of Salina. The entrance to the nest, at the edge of the car, was well protected with a mass of prickly pears. This unsuspicious rodent was observed at close range and on a later visit photos were taken of it in its nest, fully exposed by lifting the car.

The wood rats taken were found in steel traps alive and dead; when dead they were often held by the neck. The traps were seldom well covered, chopped grain being dropped on and under the pan. One specimen was found dead, held by one eye, in a mouse trap. Another was caught by the neck between the door and edge of a cage mouse trap. On King's ranch, a brush fence was well inhabited by desert wood rats. Their nests, large piles of sticks, were frequently found. Four were trapped in and near the nests, one less than an hour after setting the trap.

Neotoma cinerea cinerea (Ord).—The bushy-tailed wood rat evidently replaces the desert form at higher elevations. One was trapped in a large ledge near the Ivie farm. *N. desertorum* was also taken in this ledge. Unfortunately no trapping was done in upper Salina Canyon, where wood rat signs were plentiful.

In Logan Canyon, August, 1930, a large male was captured by forcing it out into a trap from under a large outdoor stove on a camping ground. Two were caught in a ledge in upper Logan Canyon in July.

Microtus montanus montanus (Peale).—Meadow mice of this species were taken in Salina and Logan in moist lowlands. About 21 were killed and trapped and 11 skins made. Late in June, in a hay field by the river in Salina, many meadow mice were seen while hauling of the hay was in progress. Twelve were killed with forks, a few were kept, and the others dropped after brief examinations. In Logan, nine meadow mice were trapped, July 22, by a sluggish stream in the lowlands west of the city.

Microtus nanus nanus (Merriam).—The dwarf meadow mouse was taken in Salina and Logan in the drier habitats. This species is lighter than *M. m. montanus* of the wetter habitats. Twenty-two were captured; 13 skins were made and two preserved as alcoholics. One female was captured, April 27, by a boy harrowing on the Ivie farm. It contained seven small embryos.

In Logan these mice are abundant on the campus and adjoining fields. The runways are numerous in the tangled grass along ditches and even in the alfalfa fields. The mice trapped were caught when they ran over the trigger; no baits showed evidence of being touched.

Cary[1] states, "In Colorado this small field mouse is largely an inhabitant of the boreal zones and is common far above timber line on some of the mountain ranges. . . . . *M. nanus* is found as low as 6,000 feet in the meadows along White River."

It undoubtedly has a considerable vertical range in Cache and Utah counties. In Salina, marsh hawks were often seen in the fields. In Logan, marsh hawks and short-eared owls were seen on every trip to the fields. Skulls, bones, and fur of *Microtus* were taken from the stomachs of a marsh hawk and a long-eared owl shot west of Logan and a short-eared owl shot at Howell, Boxelder Co.

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[1] Biological Survey of Colorado, North Am. Fauna No. 33, pp. 123–124.

Zapus princeps princeps Allen.—Barnes[2] does not list *Zapus*, so it was a pleasant surprise to obtain two immature jumping mice in an unusual manner. We captured a large garter snake, *Thamnophis* sp., at the Experiment Station and placed it in a barrel. Looking in a few hours later we saw two regurgitated mice. They were but slightly digested and were identified as this species.

A large male jumping mouse was brought in to the University of Utah in April, 1930, captured by a student in Morgan County. The skin is in the University collection. A female was trapped in the grass among willows at head of Logan Canyon in July, 1930.

Erethizon epixanthum epixanthum Brandt. One male was shot on the Ivie farm, April, 1929. When first seen at a distance in the top of a pinyon pine it resembled a bird's nest, where no nest had been seen the previous day. When close enough my curiosity was satisfied, but a nearer examination was desired so it was brought down with two shots from the .22 rifle. Many ticks and some biting lice were found on it. Numerous trees, mostly conifers, show evidence of the work of these rodents.

Lepus bairdii bairdii Hayden. One female in milk was secured at the head of Logan Canyon in July. She sat unalarmed near some brush among the conifers while I cautiously slipped an extra range shell into the .410 and easily knocked her over.

Lepus californicus deserticola Mearns.—The Colorado desert jack rabbit is the most conspicuous hare during the cooler months in Salina and the Gooseberry region. In the summer they are seldom seen in the valley but may be found in the mountains. Thirty-five jack rabbits were shot, trapped, and snared, from November to May. The winter of 1928–29 was unusually severe and many rabbits came in to the haystacks and onto the feed grounds among the cattle. Rabbit brush was eaten freely and furnished shelter as well. The weight of the snow bent the brush down and beneath these bowers the packed snow and excreta told of many inhabitants. Scores of rabbits were driven out of the sage and rabbit brush on each of many hunts on the Ivie farm.

At Lyman, in September, a male jack rabbit was shot. Many maggots were found in an open sore on its rump. Numbers of jack rabbits were seen in Boxelder County in July, 1930, and one shot near Snowville.

Sylvilagus nuttalli grangeri (Allen).—The Black Hills cottontail, according to Nelson,[3] is found in most of Utah. In my collection is a skin of one female taken, when in milk, in Cache Valley, near Logan, late in July, 1930. Several cottontails were seen in Sevier County and one trapped in December on the Ivie farm. The cottontails here were wary and hard to shoot and trap.

Sylvilagus audubonii warreni Nelson.—On King's ranch we found many cottontails, not too wild, and twelve or more were shot. One skin was saved and determined.

Pipistrellus hesperus hesperus (H. Allen).—The most interesting feature of the evenings spent on King's ranch was the abundance of bats flitting about the house and corrals. Two distinct sizes were seen. One was dropped with fine shot and one knocked down by Professor Fiske with his fly rod. The smaller one proved to be of this species.

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[2] Utah Mammals, Univ. Utah Bul. 12.

[3] North Amer. Fauna No. 29.

Eptesicus fuscus subsp.—The summer evenings in Salina and in Logan were enlivened by large and small bats darting about, some under trees, others in the open spaces. Two specimens were secured in Salina and four in Logan, most of them by shooting. All were saved as skins and alcoholics. The big brown bat is a fairly steady flier, more so than the smaller bats and can be hit often enough to make such attempts very interesting.

Mustela arizonensis (Mearns).—A white mountain weasel was seen several times on the Ivie farm in the winter hunting among the brush against which it showed clearly. Late in December one was trapped, pure white with tip of tail black.

At the Experiment Station, in July, a brown weasel was examined. Two boys, sons of a ranger, reported killing it when it ran at them. They used clubs and the skull was badly crushed.

At Fish Lake a large weasel was seen sitting upright on a rock. A shot failed to get it. A short time later it, or another, was seen pursuing a chipmunk. A den was found among the rocks, located partly by the musky odor. A brown weasel was seen west of Logan in July, 1930, hunting along a stream.

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NOTES ON DESERT AND DUSKY HARVEST MICE (REITHRODONTOMYS MEGALOTIS MEGALOTIS AND R. M. NIGRESCENS)

By Ruth Dowell Svihla

Some notes on the habits of the golden harvest mouse, *Reithrodontomys fulvescens aurantius*, have been recorded for the species inhabiting southern Louisiana, (R. D. Svihla, 1930). An opportunity for the study of a nearly related species, *Reithrodontomys megalotis*, was offered through the courtesy of Dr. L. R. Dice, Curator of Mammals in the Museum of Zoölogy, University of Michigan.

Observations and notes chiefly on the subspecies *R. m. megalotis* extended from September, 1927, to June, 1930. At the former date the entire stock of mice consisted of one male *Reithrodontomys megalotis dychei* from Iowa which had been in captivity for at least a year; and a female *R. m. megalotis* from Alamogordo, New Mexico, with two young born on the date of capture, July 7, 1927. The male *R. m. dychei* did not breed throughout the time of observation, although plenty of opportunity was given him. He lived peacefully with each one of his cage-mates throughout the duration of the observations. No further mention is made of him in this account.

During the summer of 1928 one female and two male *R. m. megalotis* from Carrizozo, New Mexico, were added to the now increased Alamogordo stock. Besides, these, six female and two male *R. m. nigrescens* from Prescott, Washington, were sent in during this summer. Unfortunately, the males were killed by their cage-mates before the year was out and before any breeding had taken place.

The dispositions of the *R. m. nigrescens* females were markedly ferocious. Four out of the six females killed at least one cage-mate. The *R. m. megalotis* mice also indulged in killing each other, but to a distinctly less degree. These females often killed or ate their newly-born litters, which procedure may have been due to a diet deficiency. The cannibalistic tendencies of the harvest mice and their nervous dispositions together with the fact that the females are evidently not in oestrus immediately after the birth of a litter, made a life history study extremely difficult. However, some information was obtained concerning the period of gestation, development of the young, average duration of life in captivity, and the interfertility of subspecies.

The methods employed for learning the length of gestation of these mice were the same as those used by A. Svihla (1929). As the females were not necessarily in heat immediately after the birth of a litter, a more or less trial and error method of mating had to be resorted to. The breeding was therefore extremely sporadic. The males were introduced into the cages of the females during the afternoon or evening and removed the following morning. The period of gestation was calculated from the date of introduction of the male to the date upon which the young were born. In this manner, two periods of 24 days were recorded for *R. m. megalotis* female No. 11, and one period of 23 days for *R. m. megalotis* female No. 2. Upon another occasion, although the male was not removed from the cage of female No. 2, a litter was born 23 days after the date of introduction of the male. *R. m. nigrescenes* female No. 5 was mated to *R. m. megalotis* male No. 2 on January 27, 1929, and gave birth to a litter of young on February 21. The male had not been removed from the cage, so the period of gestation was not necessarily exact, but could be no longer than 26 days in this case.

Twenty-five litters of mice were born in captivity during the period of observation. Of these, 18 were from *R. m. megalotis* matings; 4 from *R. m. megalotis* males mated with *R. m. nigrescens* females, thus indicating subspecific fertility; 2 from males of this subspecific cross bred to *R. m. megalotis* females; and 1 from a male of this subspecific cross bred to a *R. m. nigrescens* female.

Litters numbering from 1 to 7 young were born in the laboratory. The number of young per litter was distributed in the following manner: 7 litters of 1 young; 6 of 2 young; 5 of 3 young; 6 of 4 young; and 1 of 7 young.

The newly-born young were pink, hairless, and blind, and weighed 1.5 grams each. Within 24 hours after birth the pigmented dorsal stripe appears and becomes darker each day. The belly remains pink in color. By the fifth day, hair becomes visible first upon the head region and then upon the back, so that by the time the mice are a week old, they are covered with pigmented hair except upon the belly, which still remains pink. At this time the young mice of the subspecific cross are distinctly buffy about the ears. Except for this, they are superficially indistinguishable from the *R. m. megalotis* young. Silvery white hair becomes noticeable upon the bellies of the mice by the time they are 11 days old. The *R. m. megalotis* young open their eyes when they are 12 days old, while in the mice of the subspecific cross this was accomplished in 11 days. By the time the eyes are open the young mice begin to eat solid food and gradually become weaned, although they are not entirely independent of their mother until they are at least 19 days old.

The youngest age at which a male or female has been found to breed is four months and eight days. These were *R. m. megalotis* mice of the same litter, born July 7, 1927, and first bred November 15 of the same year. The female No. 2 proved the most prolific mouse of the entire stock. She produced 7 litters totalling 17 young, or an average of 2.4 young per litter, in a year's time. After this, however, she did not breed, although she was mated several times.

Owing to the general pugnacious dispositions of these mice, the average duration of life in captivity was not very long. The average span of life for 14 *R. m. megalotis* mice in the laboratory was 11 months, but, of course, this cannot be taken as any indication of their length of life in the wild state.

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HABITS OF THF LOUISIANA MINK (MUSTELA VISON VULGIVAGUS)

By Arthur Svihla

While engaged in investigating the life histories of the fur bearing animals of Louisiana, during 1926–27, I had a chance to study the mink of this region. This work was carried on under the auspices of the Louisiana Department of Conservation, to which I am indebted for the opportunity to publish these notes.

A pair of adult minks, captured alive on Marsh Island, Louisiana, during December, 1926, were brought to Morgan City for observation. They were seen to copulate on January 29, 1927. The next morning the animals were separated and kept in different cages. Seventy-five days later, April 14, five young were born. Because of a hurricane the night after the young were born two of them died and another died when 12 days old. These were preserved as alcoholic specimens and are now in the collection of the United States National Museum. All previously reported breeding information on minks gives the period of gestation as varying from 40 to 60 days. Coues, says that the gestation period in *Mustela vison vison* is six weeks.[1] Seton also says that it is six weeks, and in his "Lives," he quotes from a letter from Mr. McClintock who offers the following theory, "some minks are quite normally born in a more advanced state than others. This might account in part for the wide range of statements as to gestation period, namely from 42 to 60 days or more.[2] With this possibility, the long period of gestation reported above is perhaps not so unusual as it first appears, particularly when we consider the state of the young at birth.

Writers on the subject have usually stated that the young are born hairless. However, the young of the litter we observed were found to be covered with a coat of fine, short, silvery-white hair that contrasted very markedly with the ruddy color of the skin. The neck region was well developed, the muscles bulging noticeably here. The young were blind at birth and one young weighed 5.9 grams; another that died during the hurricane weighed 6.5 grams, so one may say that at birth these minks weighed about 6 grams. In size they were about as long as one's little finger.

Raw meat was fed to the young at the age of 32 days, five days before their eyes opened. The parent cut the skin at the back of the neck of a

[1] Fur-Bearing Animals, p. 182, 1877.

[2] Lives of Game Animals, Vol. 2, p. 536, 537, 1926.

cotton rat given it, and the young were seen to chew lustily on the exposed flesh. On several other occasions, before their eyes opened, I observed them feeding on solid food.

When 42 days old, the young first came out of their nest box and wandered about on weak, wobbly legs. The very solicitous mother mounted guard at the entrance of the nest box, and if the youngsters were too ambitious and wandered too far, she picked them up in her teeth by the nape of the neck and carried them back to the vicinity of the nest box. At first the mother allowed the young to be out for a very short time only, but this interval was increased as the young minks grew stronger, until when about 50 days old they were out most of the mornings and evenings. As they grew older and stronger they became more active and spent a great deal of their time playing a very strenuous game which consisted of biting and tumbling each other about, perhaps playing at hunting. One young mink would stalk the other and then pounce upon the unsuspecting "victim." Then the rough and tumbling would commence. The "victim" would attempt to protect itself by lying on its back with its feet upward. The other mink would attempt to bite the abdomen of the one down and if successful would give the other mink a good strong shake. This game was always accompanied by a great deal of hissing, squealing and growling from both participants. It was amazing to observe such rapid movements in these young animals.

The minks were weighed at various times; the following weights, though usually based on one individual, give an indication of their growth: April 14, just born, 5.9 grams; April 15, one day old, 6.5 grams; April 20, 6 days, 11.2 grams; May 21–22, 37–38 days, 126 grams; June 3 (male), 50 days, 175 grams; June 3 (female), 50 days, 184 grams.

Within two weeks after birth, the silvery-white hair gives place to a pale reddish-gray. The new hair is dull and lacks the luster of adult hair. Because, perhaps, of the dropping out of the silvery-white hairs this coat developes into one of a very dark red-brown. This fur also lacks the lustrous guard hairs and is very dull and fluffy in appearance.

These minks were fed chiefly upon mice, rats, rabbits, crayfish, crabs, and bird carcasses. Live cotton rats (*Sigmodon hispidus hispidus*) were placed in the cage with an adult mink. The mink always attempted to seize the cotton rat by the nape of the neck. Then rolling on its side it would grasp the rat with its forefeet, at the same time scratching it with its hind feet. Usually one squeak was all that was heard from the cotton rat. The mink would then carry the rat into the

nest box and come out for more. One cotton rat, weighing approximately 100 grams, was enough for one adult mink a day. One meal a day was found to be sufficient. These minks persisted in carrying their food into their nest boxes, and as they never completely consumed the food given them, it soon became putrid, necessitating the frequent cleaning of the nest.

With the exception of this habit of leaving all food in their nest boxes, minks were very cleanly. One corner of the cage was reserved as a defecating post. After defecating the minks squatted and rubbed the anal region on the floor of the cage. They liked to lie flat on their bellies, with neck outstretched, and rubbed this area on the floor of the cage by dragging themselves lazily along.

I have often observed the minks of both sexes rub their perineal region on the edge of a water pan in their cage. Seton describes a similar action in the marten. This suggests that rubbing of glands may be of recognitional or informational value, used in the same manner as the urinating of dogs.

These minks made a hissing and whistling noise that the residents of the region call "blowing." To them this "blowing" is supposed to be a sign of extreme ferocity. If frightened, as when caught in a trap, minks give a high pitched squeal that is always accompanied by a nauseating discharge from the perineal glands. A noise sounding very much like "fuddah-fuddah" is made when the minks are only slightly excited, nervous or displeased.

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PEROGNATHUS PACIFICUS FROM THE TYPE LOCALITY

By Jack C. von Bloeker, Jr.

Perognathus pacificus Mearns, was described August 31, 1898, from a series of three specimens taken by Dr. Edgar A. Mearns and his assistant, Mr. Frank X. Holzner, in July, 1894, in the vicinity of Monument No. 258, United States-Mexico Boundary, San Diego County, California. Several attempts were made thereafter to secure additional specimens without success. However, in September, 1903, Mr. Frank Stephens secured an adult female specimen of *P. pacificus* at San Onofre, San Diego County, California, nearly seventy miles north of the type locality. The original three are in the collection of the National Museum and the fourth is in the collection of the San Diego Society of Natural History.

Since the capture of Frank Stephens' specimen at San Onofre, renewed attempts were made to secure specimens of this apparently rare little pocket-mouse. Mr. Stephens, (in conversation, July, 1931), has assured me that there have been at least a thousand trap-nights spent at the type locality without success.

The writer spent a week during July, 1931, in San Diego, trapping in the vicinity of Monument No. 258 in the hope of securing some topotype specimens. As everyone else has apparently done, the mistake was made of trying to trap for *P. pacificus* on the ocean shore in the immediate vicinity of Monument No. 258. However, the evening of July 20, on the way back to San Diego, after having set all my traps, and while crossing the bed of the Tia Juana River, I observed a California cuckoo perched in a small willow in a field of weeds. After stalking it for some time, I followed it quite a distance into the field from the road. On the way back to the car it was observed that the ground was literally covered in small open areas with the burrows and signs characteristic of pocket-mice. It was determined that the next day a line of traps would be set in the new-found field, and sure enough on the morning of July 22, the writer was rewarded with three adult specimens of *P. pacificus*. This same field had been passed on at least three previous trips to the boundary without the slightest thought that there were pocket-mice living there, and it is certain that if it had not been for the cuckoo it would never have been investigated. For one thing, the writer has always found silky-haired pocket-mice in more or less open sandy country with scattered vegetation, in desert regions. This field gave the appearance from the road of being covered by a dense growth of

weeds and brush. However, after I entered the field, small open spaces of alluvial river-bottom sand were encountered that make an ideal situation for pocket-mice.

The morning of July 23, there was absolutely no catch, not even a *Peromyscus!* From July 24 to 26, seventeen skins and eighteen skulls were secured.

After returning to Los Angeles the find was reported at the Los Angeles Museum. It was immediately decided that Mr. George G. Cantwell, of the museum staff, and the writer should return to the Mexican boundary in an attempt to secure a series for the museum. July 29, six were secured from two hundred traps. The following day four were taken from the same number of traps and on July 31, eleven were taken from a line of two hundred and fifty traps. Four of these were kept alive for future study.

An attempt was made to secure some data on the life history of *P. pacificus*. Photographs were taken, samples of flora collected and cheek-pocket contents noted. The two series of pocket-mice were obtained from three separate fields in the bed of the Tia Juana River near its mouth. In two of the fields, fox-tail, or barleyweed (*Hordeum murinum*), salt grass (*Distichlis spicata*), ice plant (*Mesembryanthemum crystallinum*), star thistle (*Centaurea melitensis*), and telephone weed (*Heterotheca grandiflora*) were the predominating plants. In the other field arrow-weed (*Pluchea sericea*), telephone weed, salt grass, ice plant, and *Croton californicus* were the predominating plants.

In one field *Perognathus pacificus* was associated with *Peromyscus maniculatus gambelii*, *Reithrodontomys megalotis longicaudus*, and *Dipodomys agilis simulans*. In another field *Reithrodontomys megalotis longicaudus* was the only mammal trapped in association with *Perognathus pacificus*, while in the third field *P. pacificus* alone was taken (six from seventy traps). Cotton-tail rabbits, (*Sylvilagus audubonii sanctidiegi*), were abundant, and ground squirrels (*Otospermophilus grammurus beecheyi*), were common throughout the locality.

From the numerous burrows and tracks in the sand, apparently good sized colonies were present wherever trapping was done, but the animals were found to be exceedingly difficult to catch. The first bait of rolled oats failed to attract them, and the best success was attained with a mixed canary bird seed, and even this was often ignored. Practically all the traps were visited by pocket mice during the night, as evidenced by the tracks about the traps. Doping the traps with anise seed oil was also tried but with no apparent success.

During trapping operations about fifteen tails of the pocket mice were found in the traps, but on only one occasion was one of these tail-less animals taken later. From this we judged the species was plentiful in the particular fields inhabited by them, although their available range here is greatly restricted by cultivation on practically all sides, and also by the fact that the Tia Juana River bottom is subject to overflow during occasional seasons of heavy rainfall.

Ants were a great pest, not only robbing the traps of bait, but eating the animals in the traps. A species of small lizard was living in some of the old pocket-mouse burrows and grasshoppers swarmed all over the place, springing many of the delicately set traps.

Of the twenty specimens collected between July 22 and July 26, two had seeds other than trap bait in their cheek-pockets, as had six of the seventeen taken between July 29 and 31. The cheek-pockets of an adult female collected July 24 contained two seeds of *Heterotheca grandiflora*, three seeds of *Hordeum murinum*, and four trap bait seeds; an immature male collected July 26 had fifty-three seeds of *Heterotheca grandiflora;* an immature male collected July 29 had thirteen seeds of *Pluchea sericea*, and one trap bait seed; an immature female collected July 29 had nineteen seeds of *Heterotheca grandiflora*, seven seeds of *Chrysothamnus* sp. and four trap bait seeds; an immature male collected July 30 had two seeds of *Hordeum murinum*, and sixteen trap bait seeds, among them five seeds of timothy grass; an immature male collected July 30 had thirty-seven seeds of *Pluchea sericea*, one seed of *Hordeum murinum*, and five seeds of *Croton californicus;* an adult male collected July 31 had three seeds of *Hordeum murinum* and ten seeds of *Centaurea melitensis;* an immature male collected July 31 had two hundred and twenty-six seeds of *Centaurea melitensis*. In no instance was green food found in the pouches.

Of the thirty-seven specimens taken during the two trips, only twelve seem to be adult, the rest immature. One specimen (an adult female, no. 2715, L. A. Mus.) is very similar in coloration to an adult male (no. 2304, L. A. Mus.) *Perognathus longimembris brevinasus* taken by G. Willett in Cajon Wash., San Bernardino County, California. It is, however, slightly darker and measures a trifle smaller. The above mentioned specimen of *P. pacificus* measures: Total length, 124 mm.; length of tail, 62 mm.; hind foot, 17. The specimen of *brevinasus* compared with it measures: T.l., 128 mm.; T., 64 mm.; H.f., 18 mm.

Average measurements of twelve adult specimens of *Perognathus pacificus* are as follows: Total length, 124.25 mm.; tail, 62.2 mm., hind foot, 17 mm., ear (from crown), 5.75 mm.

Largest male measures: T.l., 127; T., 63; H.f., 17; Ear, 6.
Largest female measures: T.l., 125; T., 65; H.f., 17; Ear, 6.
Smallest male measures: T.l., 119; T., 62; H.f., 17; Ear, 6.
Smallest female measures: T.l., 117; T., 56; H.f., 17; Ear, 6.
Average measurements of fifteen immature specimens of *P. pacificus* are: T.l., 115.6; T., 57; H.f., 16.5; Ear, 5.
Largest measures: T.l., 122; T., 60; H.f., 17; Ear, 5.
Smallest measures: T.l., 100; T., 52; H.f., 16; Ear, 4.5

The writer wishes to express his thanks to F. R. Fosberg, of the Botany Department of the Los Angeles Museum, for identifying the plants and seeds obtained.

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SEASONAL PELAGE DIFFERENCES IN PEROMYSCUS

By R. R. Huestis

In connection with a genetic investigation of color differences in geographic races of mice, I had occasion to devise a method of recording pelage color in a numerical way. The method is simple, although the routine of carrying it out is somewhat tedious. Flat skins are made of the pelages to be measured (5) and from a constant position upon the reverse side a sample disk of skin, with its attached hairs, is removed, and examined under a low-power binocular. Hair counts are then made and the percentages of small fur hairs, of the larger banded hairs, and of the (largest) black overhairs are estimated. The disk of skin removed is 1.5 mm. in diameter and contains from 200 to 600 hairs (2).

Dark looking mice are found to have more fur hairs and more of the black overhairs. Light mice have more of the larger type of banded hairs. For example, the average percentages, in round numbers, of these different types of hairs in samples of mice from three different localities are as follows:

TABLE 1

LOCALITY	BLACK OVERHAIRS	LARGE BANDED HAIRS	FUR HAIRS
Oregon coast	16	8	76
Oregon sagebrush	10	25	65
Mohave desert	5	33	62

It may be added that mice in intermediate regions are intermediate in the percentages of different types of hair, and that identification of these types is unaffected by the fading of cortical pigment, a matter which commonly takes place as the pelage gets older. It was this latter circumstance which suggested the procuring of the figures to be presented.

TABLE 2

Hair count of Peromyscus m. rubidus

LOCALITY	SEASON	BLACK OVER-HAIRS	LARGE BANDED HAIRS	FUR HAIRS	HAIRS NOT IDENTIFIED[1]	TOTAL NUMBER OF HAIRS	NUMBER OF MICE	AVERAGE NUMBER HAIRS
Coos Bay	Winter number	2,423	896	10,464	2	13,785	34	405
	" %	*17.6*	*6.5*	*75.9*				
Coos Bay	Summer number	1,311	460	5,826	4	7,601	25	304
	" %	*17.2*	*6.1*	*76.6*				
Port Orford	Winter number	1,619	1,164	9,028	6	11,817	31	381
	" %	*13.7*	*9.9*	*76.4*				
Port Orford	Summer number	1,183	588	6,017	4	7,792	25	312
	" %	*15.2*	*7.5*	*77.2*				
Eugene	Winter number	3,013	1,786	12,896	9	17,704	43	412
	" %	*17.0*	*10.1*	*72.8*				
Eugene	Summer number	1,820	925	9,104	1	11,850	31	382
	" %	*15.4*	*7.8*	*76.8*				
All	Winter number	7,055	3,846	32,388	17	43,306	108	401±8.4
	" %	*16.3±.24*	*8.9±.28*	*74.8±.30*				
All	Summer number	4,314	1,973	20,947	9	27,243	81	336±6.7
	" %	*15.8±.32*	*7.2±.32*	*76.9±.40*				
Difference %		*0.5±.40*	*1.7±.42*	*2.1±.50*				65±10.7

[1] The hairs not identified for type are unpigmented.

I had available for this analysis 189 specimens of *Peromyscus maniculatus rubidus* trapped at three different localities. Flat skins of 108 of these were prepared during the months October to March, inclusive, the remaining 81 being put up during the remainder of the year. Although

molt may take place at any time, the division of the material decided upon presumably throws the majority of fresh pelages into the winter group, with a concomitant weighting of the other group with "worn" coats (1).

The results obtained by thus dividing the material into winter and summer pelages are presented in table 2.

It may be observed from the table that winter pelages have more hairs, at the point of sampling at least, than summer pelages. This would be expected, for individual hairs, which fall out, are not immediately regenerated. The thinning of the pelage, through loss of hair, is presumably one stimulus of pelage renewal. All types of hairs tend to fall out but this phenomenon is most pronounced in the larger banded hairs, and least pronounced in the small fur hairs.

The larger hairs of the pelage, both banded and all black, are more likely to come in contact with objects in the environment, and they are broad distally and have a narrow base. These circumstances would occasion their relatively greater loss, in comparison with fur hairs, for the latter are not only shorter but have the same diameter from base to tip. Why the large banded hairs should be lost more often than the still larger black hairs is not known. The latter type may be more strongly implanted in the hair follicles.

A reduction in the proportion of the larger banded hairs should make the summer pelages look a little darker, for darker mice have a smaller proportion of these hairs. As a matter of common knowledge summer pelages look paler, or at least browner (4). This appears to be largely, if not exclusively due to the fading of the cortical pigment of the hair tips. This difference between old and new pelages is very obvious in many specimens which have regenerated the pelage after its removal from one side of the back, and appears to be present to some extent in all specimens thus experimented upon (3).

It is an interesting fact, therefore, that cortical pigment is largely deposited at the apical ends of the hairs, that is to say, in a position to be most affected by light. Thus a somewhat correlative change of color in the mouse accompanies the changing hues of the vegetation, as the season advances. It is just another instance of the intimate adjustment between the animal and its environment. This adjustment becomes more obvious the more we study it; and, incidently, does not do that much belabored theory of protective coloration any particular harm. I might add, since the term worn has a number of connotations, that in *Peromyscus* the hair tips never show any signs of actual wear, blunting or breakage.

Some immature (postjuvenal) specimens are included in the samples used for the figures in table 2. I have ascertained that their inclusion does not produce the significant differences to be noted. It should be remembered, too, that the division of the material in terms of season, probably includes a number of worn pelages in the winter and fresh pelages in the summer group. The actual differences between pelages freshly acquired, and those much worn, are presumably much larger than those itemized in the table.

SUMMARY

1. A division of 189 *Peromyscus maniculatus rubidus* pelages into two groups, prepared in the months October to March and April to September respectively, showed summer pelages to have fewer hairs of all types.

2. Summer pelages had a smaller percentage of large banded hairs and a larger percentage of the small fur hairs, the percentage of the black overhairs being about the same.

3. Since such differences would presumably produce a relative darkening of pelage color, it is argued that the lighter color of summer pelages is largely due to the fading of cortical pigment at the hair tips.

4. It is pointed out that the deposition of cortical pigment, largely at the hair tips, and thus closest to the light, may be an adaptive characteristic; the fading of the pelage will accompany the decomposition of chlorophyll in the surrounding vegetation.

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METHODS OF INDICATING THE ABUNDANCE OF MAMMALS

By Lee R. Dice

For many kinds of ecological studies dealing with mammals it would be very valuable if the number of individuals of each species per unit area in each type of habitat could be known. As a basis for the development of policies for wild life management also it is highly important to know the abundance, in the various districts concerned, of the several species under consideration.

Unfortunately, it is extremely difficult to count wild mammals. Many species are nocturnal and all are more or less shy and hard to observe. It is very difficult even to determine the number of beavers living in one house, for the animals move about a great deal, and the whole family will almost never be in view at the same time. To count the less conspicuous forms and those less restricted to one locality is practically impossible.

A mammal census might be made on a small area by killing and counting all the individuals of all the species living there. Care would have to be taken that during the course of the census individuals would not leave the area or wander in from the adjacent areas. It would, moreover, be difficult and very laborious to shoot or trap every individual on an area of any considerable size, yet it is necessary that such an area should be large enough to contain a representative natural assemblage of all the species. The difficulties would be so great as to make the method usually impracticable. Furthermore, the method would be unsuitable for those studies in which it would be desirable to retain the fauna in natural condition.

Another possible method of making a mammal census would be to catch the animals in live traps and release them after numbering and marking, so that if they are caught a second time they would not be counted again. This method would produce some disturbance in the area, but by no means as much as would be caused by killing the population. It also would require a great amount of labor, and it would be difficult ever to catch all the individuals of some of the more shy species.

As actual counts of the number of individuals of each species of mammal per unit area are impracticable it would be very useful if some method could be found for securing a measure of relative abundance, and several such methods have been suggested.

The relative terms: rare, few, numerous, common, and abundant,

or similar expressions, are commonly used by ornithologists as a scale of abundance for birds, and they often have been employed, and usefully so, by mammalogists. These terms, however, are rather indefinite, and no two persons, even if both are trained observers, will use the scale in the same way. Furthermore, it is well known that the same observer will unconsciously use a different grading for each different kind of animal. For instance, the wolf might be ranked as "abundant" when it was far less numerous per square mile than the chipmunk ranked as "few" or "rare."

A method of stating abundance of small mammals in terms of "trap-nights" was at one time suggested by Grinnell.[1] The total number of traps set in each habitat is multiplied by the number of nights they are set. But there are several difficulties in the use of "trap-nights" as units: All mammalogists are not equally skilled in the setting of traps; the distance the traps are set apart varies; the weather conditions undoubtedly influence the activity of the animal and therefore the number coming in contact with the traps; the several makes of traps vary in their effectiveness for the different kinds of mammals; the traps themselves vary in efficiency depending on their previous use and exposure to the weather; and the number of animals caught usually decreases each night the trap-line is set.

It is obvious that each mammal taken on a trap-line decreases temporarily the number of individuals available to be caught, and, therefore, the catches of the "first trap-nights" are more nearly comparable than the catches of all the "trap-nights." One season in Michigan I kept a record of the catches of the "first trap-nights," as well as the total catches from each habitat.[2] Several characteristic but somewhat rare species of small mammals failed to be caught on the first nights, but were taken on the same trap-lines on later nights. For the larger species the method is obviously very inadequate. I conclude, therefore, that the number of individuals trapped per "first trap-night" does not give a fully reliable index of the relative abundance of the several species living in a habitat.

Taylor[3] has suggested several methods of measuring the abundance of rodents on the range. Besides actual counts of the number of individuals and counts of the number of each species taken per trap-night per unit area he has experimented with counts of animals seen along a line of known length, with counts of the number of animals killed at

[1] Grinnell, Joseph. Univ. Calif. Publ. Zool., vol. 12, p. 92. 1914.
[2] Dice, L. R. Occ. Papers Mich. Mus. Zool., no. 86, pp. 6–13. 1920.
[3] Taylor, W. P. Ecology, vol. 11, pp. 523–542. 1930.

stations where a standard amount of poisoned wheat had been placed, with counts of burrows or rodent workings per unit area or per unit of distance traversed, and with counts of number of fecal pellets of jackrabbits and cottontails per unit area and per unit length of transect. Some of these methods offer considerable promise of securing valuable information about the relative abundances of certain species, but the indication is that somewhat different methods must be employed for each different kind of mammal studied.

Kenoyer[4] has suggested that the relative abundance of mammals and other animals might possible be expressed by the method developed for plants by Raunkiaer and by Gleason.[5] The method proposed avoids the counting of the number of individuals of each species on each unit area studied. A number of unit areas (quadrats) of equal size are laid out in the same type of habitat and the occurrence of each species listed for each quadrat. For best results 25 to 100 quadrats should be counted. If a species occurs in all the quadrats it has a frequence of 100 per cent; if in only one quadrat out of 25 it has only 4 per cent frequence. The quadrats can be of any uniform size large enough to contain a good sample of the flora or fauna of the habitat. It is found by Raunkiaer for plants that the species of low frequence, the rare forms, are greatest in number; there may be a moderate number of species of high frequence (dominants); but the forms of intermediate frequence are fewest in occurrence.

The difficulty of securing a complete or nearly complete list of the mammal fauna in each of a number of small areas would be considerable, and the method needs some modification to be made useful for studies of mammalian abundance. By recording the species of mammals seen in passing through each of a series of unit distances, say each 100 paces along a path, or the species trapped in each unit of, perhaps, 25 traps, this method might be of value.

As an example of a possible useful method of a similar character as applied to a single species I will mention a study of the abundance of snowshoe hares. This study was made for the Michigan Department of Conservation and in the northern peninsula of Michigan. The period of field observation extended from August 21 to 29, 1927. I drove in an automobile over the main highways of the peninsula, stopping every 10 to 30 miles, wherever the cover seemed suitable for these animals, and examining the area immediately adjacent to the road for the characteristic pellets and runways of the hares. As no other species

[4] KENOYER, L. A. Ecology, vol. 8, p. 346. 1927.
[5] GLEASON, H. A. Bull. Torrey Bot. Club, vol. 47, pp. 21–33, 1920.

of rabbit or hare occurs in the region there was no danger of confusion with any other form. Altogether 37 places were examined, and of these 33 yielded fresh signs of the presence of the animal. This would be a percentage of 89, and might be considered to represent a fairly good population of hares. The fact that hares were fairly numerous in suitable cover was corroborated by the statements of residents, and by finding hares lying dead in the road, where they had been killed by automobiles. With a larger number of observations from localities selected at random it would have been possible to obtain comparative statements showing the types of habitat most favored by the hares, and also the sections of the state where they were most common. It should be borne in mind that in the above study only apparently suitable situations were examined and that the relative abundance of 89 per cent obtained does not apply to the whole territory, but only to the most favorable parts. If the areas for examination had been selected at random, for example, every 10 miles exactly, the percentage of signs of occurrence would have been much lower.

Although the method here employed for securing a measure of the relative abundance of snowshoe hares might be adapted to other individual species, it is clear that this method would not usually give a reliable measure of the abundance of one species compared to that of another species of somewhat different habits. The method of determining the abundance of each species must be adapted to the habits of the animal studied, and methods which would apply to snowshoe hares would not be useful if applied to deer.

The substitution of time units for space units in enumerating species or individuals of animals has been suggested by Grinnell and Storer[6] and by Linsdale,[7] and I have suggested a combination of these proposals for field studies of bird abundance.[8] By this method the species or individuals seen or secured per day or per hour are listed and these time units substituted for the quadrats (space units) of the plant ecologists. This method might be adapted to a comparison of the abundance of a particular species at different places or at different times. But the method, although probably very useful as applied to birds or perhaps for certain kinds of diurnal mammals, would not seem suitable for comparing the numbers of the several species of mammals which inhabit

[6] Grinnell, Joseph, and T. I. Storer. Animal Life in the Yosemite, p. 22. 1924.

[7] Linsdale, Jean. Condor, vol. 30, pp. 180–184. 1928.

[8] Dice, L. R. Auk, vol. 47, pp. 22–24. 1930.

one region or one ecological habitat. Too few mammals are abroad in the daytime to permit anything like a complete record of the fauna of any area by sight observations alone, and if we depend on trapping apparently nothing would be gained by using time units.

It is my opinion, after considerable field experience, that the most satisfactory method so far developed for expressing relative abundance of mammals is to list the number of individuals of each species taken or observed in each ecological habitat during the period of field work.[9] Individuals seen but not trapped should be included in the lists only if positively identified as to species. I have made it a practice to include in the lists those species recognized in the habitat only by signs, and also those reliably reported by other observers, indicating in each case the basis for including the form.

I would urge the desirability of placing each trap-line entirely within one type of ecological habitat, and also of recording all observations according to habitat. By so doing it is easy to list the mammals from each kind of habitat separately, and the ecological distribution of the mammals can be determined at the same time as the mammalian fauna of the region.

The comparative abundance of the several species within one habitat might be expressed in percentages of the total number of individuals of all species taken or seen in that habitat. But such a percentage comparison would give a false appearance of precision. The trapping methods employed for the larger species are very different from those employed for the smaller forms and the results obtained are not exactly comparable.

If it is desired to compare with some exactness the abundance of the various species of mammals in various habitats or in different regions, the amount and quality of the trapping and observations should be equal in each place. This, however, is impracticable. Actually the figures of abundance obtained apply with fair accuracy only within one habitat. Even within the same habitat the catches of the several species will not indicate the true comparative abundance, because the traps and trapping methods employed will always favor some species at the expense of the others. Nevertheless, a statement of the numbers of individuals of each of the several species found in each of the habitats in an area does give a rough indication of comparative abundance.

[9] DICE, L. R. Occ. Papers Mich. Mus. Zool., no. 159, pp. 17-33. 1925.

SUMMARY

The relative abundance of the various species of mammals living in a given area may be determined roughly by the usual methods of trapping and observation. However, the comparison is very imperfect, for the methods suitable for determining the abundance of one species are not so well applicable to another species having different habits. Actual counts of the individuals of the various species living on any given area are usually impracticable.

Another kind of relative abundance is that comparing the frequency of occurrence of a single species in different localities, in different types of habitat, or at different times. By the development of a proper field technic, which must be more or less different for each kind of mammal, it seems possible to secure indices of abundance for any given species. These indices of abundance are much more easily obtained than actual counts of individuals per unit area, while they are of considerable value in studies dealing with ecology or wild life management.

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CENTRAL NERVOUS SYSTEM OF THE PORPOISE TURSIOPS TRUNCATUS

By Orthello R. Langworthy

Some years ago a number of workers interested in sea-living mammals visited the porpoise fishery operated by Howard I. Wordell on the coast of North Carolina. The problems of the different members of the expedition were quite different. One wished to obtain skulls for biometric studies; another investigated the relation of the facial musculature to the differentiation of the blow-hole mechanism. Wislocki (1929, A and B) obtained well fixed material for histological study; he has described the structure of the hypophysis and the differentiation of the lung in relation to the aquatic environment. The author was particularly interested in the nervous system.

It is known that the nervous system of Cetacea has great importance and significance from the standpoint of a neurologist. The conformation of the skull has undergone such remarkable changes in this group of mammals that widespread mechanical adaptations have occurred in the brain. Furthermore, it must be remembered that the Cetacea are an

extremely specialized group of mammals. Adapted to life in the water, they have diverged in a radical way from the general course of mammalian development. Their ancestors were terrestrial Mesozoic mammals, related most likely to primitive Ungulate or Carnivorous stocks. In the process of adaptation to the aquatic environment the hind-leg was lost, so that only minute vestigial remains are found within the body of the porpoise and other Cetaceans. The fore-leg likewise underwent a marked reduction, changing its conformation and becoming a flipper. The tail developed into a powerful muscular appendage, supplemented by the growth of caudal flukes, highly adapted to locomotion in the water. Besides the limbs, other surface structures have been markedly modified. The skin has become thick, smooth and hairless, and has lost its sweat glands as well as its sebaceous glands. The pinna of the ear has been lost and the external auditory meatus reduced. Furthermore the eyes and eye-lids have undergone pronounced modifications. Many of these changes upon the surface have been brought about to further the ease of gliding through the water.

There have been equally pronounced adaptations to the exigencies of an aquatic existence in many of the internal organs which it is unnecessary in this connection to describe in detail. The entire respiratory tract, including the nasopharynx, trachea and lungs, shows an extreme specialization, related undoubtedly to needs of regulating respiration during periods of submergence in water, when the outside oxygen supply is cut off and the pressure of the medium compressing the animal's body is a physiological factor which must be compensated (Wislocki, 1929 B). The cardio-vascular system also exhibits changes correlated with the peculiar mode of breathing and the oxygen consumption of the animal. Similarly the mouth, esophagus and stomach have been curiously modified and adapted to the mode of feeding of an aquatic mammal. Another instance of adaptation might be cited in the female reproductive tract which is specialized for aquatic parturition and suckling.

Some of the most remarkable structural changes have occurred in the region of the head. Nearly all the changes in the skull have a bearing on the shape of the cranial cavity and the conformation of the brain and its appendages. A marked foreshortening of the skull has occurred, involving a telescoping of the structure so that the maxillary bones broadly override the frontal bones, producing a cranial cavity which is deep and wide but relatively short antero-posteriorly. The blow-hole, a complex naso-pharyngeal structure, adapted to the regulation of intake and escape of air, has developed anterior to the cranial vault. With

the formation of the blow-hole mechanism, the nostrils have shifted to the dorsum of the head, giving place to another curious structure, a deposit of fat or, in some cetaceans, a spermaceti organ lying on the facial region in front of the blowholes.

An excellent account of the evolution of Cetacea is found in Weber (1904) while a detailed discussion of the phylogeny of whales based on a study of skeletons, recent and fossil, is presented by Kellogg (1928). Concerning the significance of the so-called telescoping of the skull an interesting paper by Miller (1923) may be consulted; Howell (1930) has published an important book dealing with the adaptations of aquatic mammals. Hatschek and Schlesinger (1902) gave a splendid account of the minute structure of the brain stem of the dolphin; Hatschek (1896) described the spinal cord and spinal nerves of the dolphin.

The material obtained at Cape Hatteras consisted of ten young adult males, each about eight feet long and weighing six hundred pounds, all caught on a single morning. It was hoped that some neuro-physiological observations could be made. Specifically it was planned to stimulate the cerebral cortex with a mild faradic current delimiting the motor area and to decerebrate some preparations. This work was unsatisfactory because of the conditions under which it had to be carried out. Six brains, however, were carefully removed and shipped to Baltimore for study. Drawings were made of the intact brain and of brain dissections by Mr. James Didusch of the Carnegie Institution of Washington, some of which illustrate this paper; the author wishes to express his appreciation and thanks for them. Through the kindness of Dr. Adolf Meyer several serial sets of sections of the brain were cut and stained by the Weigert-Pal method.

A fairly detailed account of the macroscopic and microscopic structure of the porpoise brain has been published in another place (Langworthy, 1931 A). A further report (Langworthy, 1931 B) discussed the complicated cerebral cortex of the porpoise as evolved on the basis of the great influx of auditory stimuli into this region. The present paper introduces these studies of the brain of the porpoise to the large group of mammalogists interested in sea dwelling mammals and describes the general structure of the brain in connection with the drawings.

The ventral surface of the porpoise brain is depicted in figure 1. The whole structure is foreshortened and wide. The caudate nuclei lie upon the surface at the ventral tip of the frontal lobes. The temporal lobe lies behind the fissure of Sylvius: the rhinal fissure may be identi-

fied at the pole of the temporal lobe. The small hippocampus major lies ventral to the rhinal fissure.

The cerebellum is well developed with the hemispheres and flocculi as prominent features. The flocculi are said to be well differentiated in all water living mammals. It is believed that the cerebral and cerebellar hemispheres develop coincidently. Both are large here and have

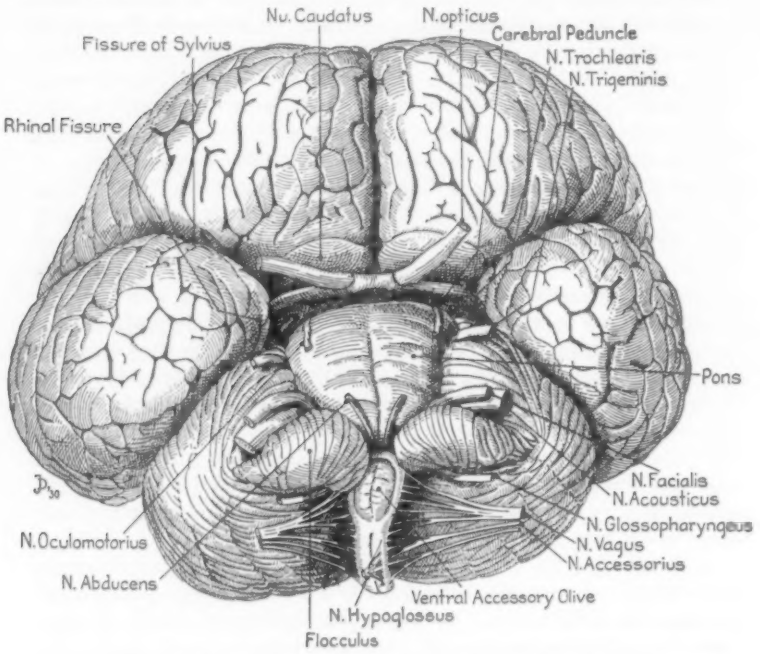

FIG. 1. VENTRAL SURFACE OF PORPOISE BRAIN

strongly developed pathways connecting one with the other as evidenced by the size of the pons.

The cranial nerves may be identified in this drawing of the ventral surface of the brain. No olfactory nerve or bulb was found in any of the brains examined. The nuclei and tracts that are thought to be olfactory may be identified in the brain but all are small.

The optic nerves show no features of particular interest. It has been

shown in the case of the dolphin that all the optic fibers decussate in the chiasma. The eyes of the porpoise are set far laterally upon the surface of the head so that only panoramic vision is possible and there can be no fusion of the visual fields permitting binocular stereoscopic vision. The oculomotor, trochlear and abducens nerves to the extra-ocular muscles of the eye are not remarkable; there is little movement of the eyeball.

Likewise the trigeminal nerve is of no particular interest; the ophthalmic branch is small but the maxillary and mandibular are of good size.

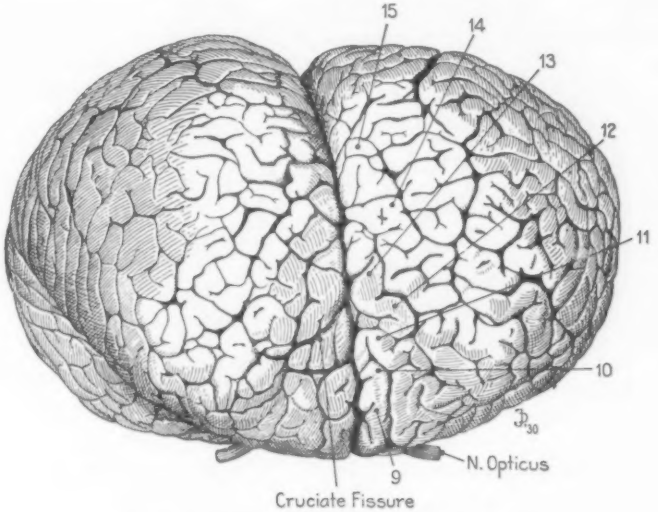

FIG. 2. ANTERIOR SURFACE OF PORPOISE BRAIN

The facial musculature has differentiated to supply that interesting structure, the blow-hole. The facial nerve is large. The acoustic nerve is particularly well developed and it was found that it is the cochlear portion that has undergone great differentiation. The glossopharyngeal, vagus, accessory and hypoglossal nerves are not remarkable.

Figure 2 depicts the anterior surface of the cerebral cortex; the complexity of the pattern of sulci and gyri is at once apparent, surpassing that found in the cortex of man. The falx cerebri is absent at the frontal end of the longitudinal fissure and the gyri of the two sides interdigitate

in the midline. The anterior pole of the cortex is flattened due to the conformation of the skull in this region.

The numbers indicate microscopic sections of the cerebral cortex shown in photographs in another paper (Langworthy, 1931 A). Many sections from different portions of the cortex were studied. It was found that the whole gray matter was poor in cells and that these were spaced at wide intervals. There was no well defined layering of the neurones such as is characteristic of the cerebral cortex of Primates.

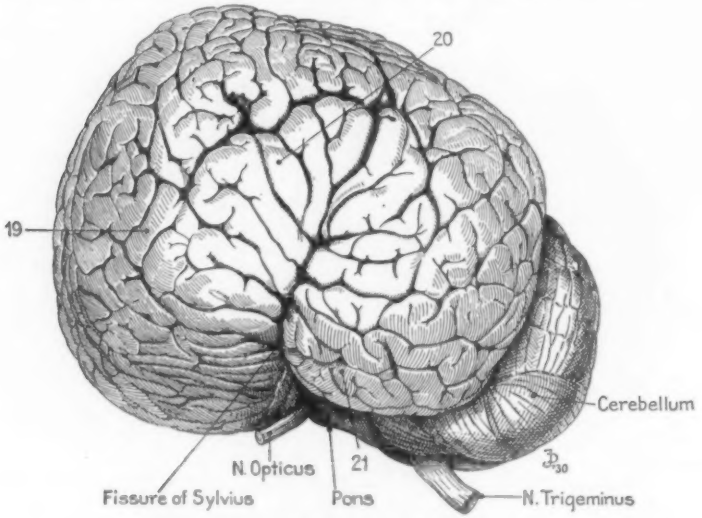

FIG. 3. LATERAL SURFACE OF PORPOISE BRAIN

The granular layer which is considered to be the receptive layer was identified in all portions of the cortex except in the motor area. The supra- and infra-granular pyramidal layers were, in most regions, poorly differentiated. Because of this primitive development it was difficult to divide the cortex sharply into areas having characteristic cytological structure. However, certain regions were definitely recognized.

The motor cortex was distinguished by the large pyramidal projection cells and by the absence of a granular layer. It surrounds the cruciate sulcus in the region indicated by numbers 10, 11 and 12. Anterior to this is the premotor area which extends to the very anterior tip of the

cortex There is no large association area in the anterior portion of the cortex.

Posterior to the motor cortex is another area characterized by a well developed granular layer which is probably a sensory projection area receiving general cutaneous and proprioceptive impulses. Because of the structure of the skin it is probable that cutaneous sensation is poorly differentiated. Relatively small numbers of fibers carry proprioceptive

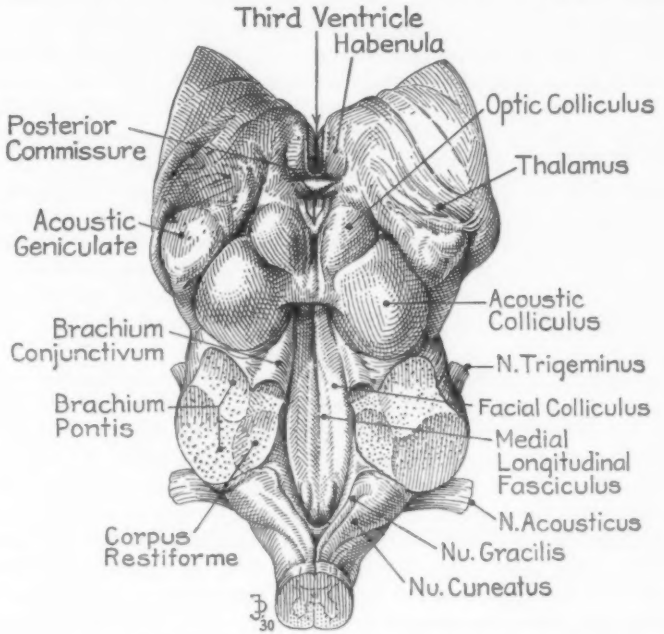

FIG. 4. DORSAL SURFACE OF BRAIN STEM OF PORPOISE

impulses to the cerebral cortex. These motor and sensory areas are surrounded by cortex having a very primitive structure.

The lateral surface of the cerebral cortex is shown in figure three. Because of the rotation of the forebrain the fissure of Sylvius extends in a vertical direction instead of horizontally as in man. A number of sulci spread out in a fan-shaped manner from the fissures of Sylvius and terminate in the semicircular supra-sylvian fissure. The auditory fibers

penetrate the gray matter of the cortex just posterior to the Sylvian fissure and around this area has developed a large acoustic correlation center.

The optic projection fibers terminate around the calcerine fissure at the mesial tip of the occipital lobe.

It remains to discuss the enormous development of the cerebral cortex of the porpoise. Obviously this growth must be dependent on the penetration of large numbers of sensory impulses into this region and the formation of correlation centers. The one group of sensory fibers of enormous size in the porpoise brain is the acoustic; all the acoustic tracts and end-stations are extremely well developed. This is evident in fig. 4. In most mammals the optic colliculus is larger than the acoustic but in the porpoise the acoustic colliculus exceeds the optic by far. The acoustic colliculi form the conspicuous landmarks on the dorsal surface of the midbrain and they are connected across the midline by a commissure. The acoustic geniculates are also much larger than the optic and their surfaces are not smooth but are thrown into distinct folds (figure 4). Examination of sections of the thalamus reveals the fact that large portions of this structure form an acoustic nucleus and from these cells a large group of acoustic fibers extend upward to the cortex.

It has been suggested that the development of the optic structures, particularly the acquisition of binocular stereoscopic vision, was responsible for the rapid growth and differentiation of the cerebral cortex of Primates. In like manner the development of the cortex of the porpoise appears to be dependent on acoustic impulses. Whether this acoustic mechanism permits a great acuity of hearing or whether it is dependent on the reorganization of the cochlea to function in a fluid medium is not clear. It is hardly possible that the acoustic nerve has taken over vestibular function controlling equilibrium and patterns of tonus in the striated musculature of the body. It must be remembered that the cellular structure of the cerebral cortex of the pospoise is much more primitive than that found in Primates.

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PARTURITION IN THE AGOUTI, WITH NOTES ON SEVERAL PREGNANT UTERI

By Robert K. Enders

Parturition, in mammals other than man, is not observed frequently. Reports concerning this process in the common laboratory animals are few and for the most part fragmentary. Even among the domestic animals the pathological cases observed and reported outnumber the normal. Because of the scarcity of descriptions of parturition in wild mammals it is thought worth while to present the following observations on parturition in an agouti, *Dasyprocta punctata isthmica*. These were made at the Barro Colorado Island Laboratory, Canal Zone, where the writer was securing material for the study of the embryology and reproduction of the genus *Marmosa*. This work was done as a Fellow of the National Research Council, Washington, D. C.

No measurements of the female observed in parturition were secured. However, two females taken by the writer in the same locality were each 545 mm. long, and weighed 337.0 and 400.8 grams respectively; the heavier of the two contained two embryos, 167 mm. in length.

The female which later was observed in parturition had been visiting the laboratory for some months and had become tame enough to eat from the hand. The writer, sitting on a low step and using a ripe banana as reward, had, on several occasions, coaxed her to jump up onto his lap. This confidence was of great convenience when close observations had to be made. Of course, hunger was the cause of the actions of the agouti, and her hunger must have been great to overcome her natural timidity. This behavior on the part of an unusually shy mammal arose, possibly, from the condition of her teeth. She had but one incisor tooth, the right upper, which was much too long and too curved. Only with difficulty could she pick up food that was too heavy or large to convey to her mouth by the manipulation of her tongue. Even so soft an object as a ripe unpeeled banana caused her great difficulty. Moreover, her molars were too worn to masticate food as hard as ship's bread, even after it was in her mouth. Nevertheless, she was always sleek and glossy, appearing to be kept in splendid condition on her diet of peeled bananas, papaya, bread and cooked rice.

During this period the agouti lived under a chest of drawers which had been placed under a lean-to shed at one end of a work bench. The house against which the shed leaned was occupied by two Indians. The chest rested upon a base made of two two-by-four timbers set on edge

and running lengthways of the chest. These timbers rested on cement. The chest rested on two inch pipes set across the timbers, thus making a space about eight inches high—for the drawers did not come down to the base—and easily visible through the two-inch slit thus formed between the chest and the timbers. The area under one end of the chest was occupied by a collection of leaves and small sticks from the jungle, chips from the vicinity of the chopping block, and some brown wrapping paper. From time to time the accumulation over-flowed the space between the timbers and spread over the area in front of the chest; removal of this surplus led to its slow replacement. However, about half of the area under the chest had a very scanty covering of leaves, and it was here that the agouti was usually found and the young were born. Conditions and arrangements here were, probably, not unlike those found in the burrows where these animals make their homes.

By lying flat on the cement floor and looking through the slit between the chest and the timbers a good view of the interior was possible, and as this had been done from time to time, the animal was not disturbed by the presence of the observer.

On November 16 behavior was observed that might have been connected with mating. The writer could not be sure of this nor could be positively identify the female agouti as being the one that came to the laboratory. However, a female agouti pursued by another agouti, sex undetermined because of its wildness, approached within ten or twelve feet of the writer while he was in the forest. The other dashed off as soon as it became aware of human presence, although the pursued showed no signs of fear. After this date the agouti under observation went into the jungle less and less, and spent more time lying under the kitchen, apparently enjoying the cool, moist earth. The date is given because it may indicate the period of gestation.

In passing the nest at 10:35 a.m., December 30, the writer looked in, as was his habit, for the agouti had been showing signs of heaviness. A young agouti was observed which was making little coughing noises and, very wet, was standing between the forelegs of the female. The umbilical cord which was about ten inches long was intact and the remains of the amnion were lying on the ground. The mother was licking the young one against the direction in which the hair lay, while it attempted to wander away, but could not as it was held to the mother by the umbilical cord. The female made soft grunting noises from time to time which stopped if any sudden movements were made. This activity of licking the young one was continued until 10:42, at which

time she licked her vulva and then her paws and cleaned her head with her paws. Three minutes later (10:45) she took the cord in her mouth and jerked her head as if to pull the cord loose or sever it. During the entire period she was on her feet with the hind-quarters held low. After two minutes of unsuccessful attempt to pull out the cord she licked her genital opening again. Some material from the orifice, the nature of which could not be seen, was eaten.

By this time (10:47) the young one was trying to crawl from the comparatively bare floor where he had been born to the nest of leaves under the other half of the chest, but was held by the cord. After several efforts the cord broke about two inches from the genital opening of the mother, leaving about eight inches attached to the young one. Instead of going on after this occurred, he returned to the mother and was licked vigorously all over, special attention being given to the umbilical and anal regions.

At 10:50 the mother ate the remains of the amnion, sitting on her hind-legs, and holding it in her paws, squirrel-fashion. Two minutes later (10:52) she repeatedly drew the portion of the cord still attached to the umbilicus of the young agouti through her teeth, holding the cord in her forepaws, but exerting no tension on the end attached to the umbilicus. As mentioned above, her teeth were very faulty, so the attempts to sever the cord were futile. At length the young one wandered off with the cord looped about its left hind leg.

Whenever the mother would crouch down, the young one would go to her and crawl under her belly, working down to the inguinal region. At 10:57 the female, which had been licking herself after her unsuccessful attempt to sever the cord from the young one, lay on her side resting. At once the young one came to her and nuzzled about her neck probably searching for a nipple. In another minute (11:00) the mother arose, assuming a crouching position with the hind-legs well apart and the hind-quarters near the ground. A very definite contraction was observed to start at about the level of the diaphragm and involving the muscles of the abdominal region. Two contractions followed each other in rapid succession. After these passed, the female again licked the young one. In five minutes (11:05) long, strong contractions were again seen with the female assuming the squatting posture. Another contraction followed in two minutes. In the meantime the young one wandered about somewhat unsteadily, complaining whenever the cord, the maternal end of which was under the foot of the female, limited the range of movement. At intervals between wanderings the

young one nuzzled against the mother only to wander off again without finding a nipple. The female was now practically sitting on her haunches. The young one, on approaching her, usually worked along her ventrolateral surface toward the inguinal region.

At 11:12 the right rear nipple was found and nursing sounds were audible. The connection was brief, for the female raised her hindquarters during a vigorous contraction. When the young one moved away the cord hobbled both hind legs. It returned as soon as the female settled down following the contraction and again found the nipple, this time lying on its side with one hind foot in the air, nursing. The mother was still crouching.

More contractions followed (11:20 and 11:21) during which the nursing young was dislodged, and at 11:23 liquid was ejected with some little force from the genital opening. This liquid had much of the appearance of white of egg. It was licked up at once, and the small amount that had struck the young one was removed with vigor by the female.

A minute later (11:24) a definite attempt was made to expel something, the attempt being followed by a pause during which the vulva was licked as more of the liquid had appeared during the straining. Finally she sat on her right haunch (11:25) and lifted the left hind leg in order to reach the genital opening more easily. At 11:27 another strong contraction brought her to a squatting position. The young one took advantage of the momentary rest following this "pain" to find a nipple, but was soon cast off because of the restless movements of the mother. At 11:30 there was a series of contractions with increasing restlessness, the female moving about in a crouching position, head up, front feet close together, hind legs wide apart, and the hind quarters held low. The young one went off on a tour of the surroundings, climbed over the two-by-four timber at the edge of the nest area, but returned to the nest immediately. On its return from one of these wanderings (11:33) the mother made nervous attempts to eat the cord which was still attached to the young one, but was not successful. Following these futile efforts, she was less restless, lying on her side while the young one nursed.

At 11:47 she jumped to her feet and assumed the crouching position, while four contractions occurred in rapid succession, liquid being ejected in the meantime. These contractions resulted in birth of a second young one (11:50). It was completely enclosed in the amnion and was ejected in one prolonged contraction, head first. At once the female tore the

amnion in the umbilical region and, as rapidly as possibly, ate it, pulling it away from the ventral surface and working toward the head. The young one was breathing rapidly, as could easily be seen, for the amnion over its nose was drawn against the nostrils at every inspiration. When the amnion was pulled away from the head the eyes were wide open. The young one sneezed as soon as the nose was uncovered. After stripping off the portion of the amnion that had extended over the head and back, the female left it on the ground while she gave her attention to licking the latest arrival. The umbilical cord was still intact. The young one sat between the forelegs of the female and was licked against the direction of the hair. It was, apparently, at this stage that I had discovered the first born. Seven minutes after the birth (12:02) the remainder of the amnion was eaten. The female then (12:04) lay on her side resting and nibbling now and then at the placental end of the intact cord. All three animals were quiet, which was a marked contrast to the twitterings the young had been making and the previous soft grunts of the adult.

Observations were discontinued at 12:15 when the family was still resting. The umbilical cord attached to the first born was about eight inches long, and the cord of the second was still attached at the umbilical and placental ends. When observations were renewed at 12:25, the female was resting on her side and both young were attempting to nurse. The broken umbilical cord was still attached to the first born, but the entire cord of the second had been disposed of. The female ate food that was offered. The next half hour the female rested while the young wandered about the nest, climbing out over a four-inch timber and then returning to the mother from time to time.

At 1:35 the second born was caught and examined. His eyes were wide open with eyelids fully formed. The body was completely covered with hair of the typical agouti color and pattern and was long over the rump as in the adult. The vibrissae were long. The soles of the feet were richly pigmented with black. He was able to move about freely, showing a high degree of coördination. He would remain in any spot when put down, but struggled while held. His weight was 211 grams. After being banded he was returned to the nest, whereupon the mother gave a warning grunt and took a defiant attitude for a moment. Whenever she was alarmed and "froze," the young "froze" too, although no warning note was sounded.

As usual, the female put in her appearance at the door at about 6:00 p.m., coming alone. After feeding for some time she was seen to have

something in her mouth resembling meat and to be moving toward the nest with it. On being pursued, she dropped the object (6:05) which proved to be an after-birth. It was fresh and warm, with uncoagulated blood at the end of the frayed cord. Its weight was 39.2 grams.

After returning to the laboratory she fed for twenty minutes, finally returning to the nest where she was met with twittering chirps not unlike those of contented chicks. By 6:30 everything was quiet.

SUMMARY

1. Parturition in the agouti, *Dasyprocta punctata isthmica*, was observed under approximately normal conditions.

2. Observations are presented that indicate a probable gestation period of forty-four days.

3. Two young were born, an interval of about one hour separating their births.

4. The second, born under close observation, was enclosed in the amnion, which was removed by the mother.

5. Parturition occurred with the female in a squatting position.

6. A placenta, still fresh and warm, was recovered about six hours after the last birth.

7. The new-born young were fully haired, patterned like the adult, had the eyes open with the eyelids fully formed, and were able to move about easily and rapidly.

NOTES ON PREGNANT UTERI

The writer is indebted to Dr. George B. Wislocki for the privilege of examining several uteri and for his aid and suggestions in their examination.

The first specimen was received from the National Zoological Park, Washington, D.C. The right ovary of this specimen contained two corpora lutea; the oviducts were short and straight, with thick muscular walls and large lumen. The left horn of the bicornuate uterus was empty, while the right horn contained two fetuses near term. The parametrium presented an interesting condition as regards the character of the blood vessels. An artery and a vein passed along the border of the parametrium, the artery giving off branches which broke up into an arterial rete, this in turn resolving itself into groups of parallel convoluted arteries which crossed the parametrium and penetrated the uterus. The veins were perfectly straight and large, occurring in the ratio of one vein to ten or twelve arteries. The placentae had a meso-

metrial attachment[1] and were normal. Apparently the two fetuses were normal with a normal course of gestation up to the onset of labor. At this point the right hind limb of the lower fetus engaged, which resulted in failure to expel the uterine content. The limb of the fetus was dislocated with trauma to the soft parts as well as to the pelvis and thigh of the mother. The death of the female followed, with the two fetuses still unexpelled. One fetus was 170 mm. long.

The second uterus examined was from Bruja Point, Panama, and had been secured by J. B. Shropshire. This female was normal, near term with four fetuses, two of which were in either horn. The tubes were straight, lying along the same axis as the uterus, excepting a short section which returned upon itself for the distance of half an inch at the level of the ovary. The openings to the tubes were small and were surrounded by delicate fimbriated infundibula, with the formation of a small ovarian bursa which only incompletely contained the ovary. No circumscribed corpora lutea were found in either ovary; the ovaries were approximately the same size. There were two internal os, one in each horn, which united caudad of the separating septum to form a single external os. Posterior and lateral fornices were present around the cervix. One fetus measured 155 mm.

The third uterus was from an animal collected on Barro Colorado Island, Canal Zone. This was a much less advanced pregnancy, as one fetus was but 135 mm. long. The two fetuses were in the right horn; the left was empty. Although the right ovary was larger than the left no distinct corpora lutea were found. Even at this stage the hair and claws of the fetuses were well developed.

[1] Becher, Hellmut. 1921. Die Entwicklung des Mesoplacentariums und die Placenta bei Aquti (Dasyprocta azarae Schl.). Zeitschr. f. Anatomy u. Entwicklungsgeschichte, vol. 61, pp. 337–364.

A METHOD FOR THE FIXATION OF MAMMALIAN CHROMOSOMES IN THE FIELD

By W. E. Hoy, Jr., and Kalman Berkowitz

From the standpoint of cytology and genetics the study of chromosomes is of considerable importance. Such study requires not only an exact enumeration, but also a study of the shape and size of the individual chromosomes and their history in the several phases of mitosis. There are, in general, three possible sources of suitable material in mammals; first, the dividing cells of the testis, second, the dividing cells of tissues from embryos or very young individuals, and third, the dividing mesoderm cells of the amnion.

It is highly desirable that our knowledge of the number and type of mammalian chromosomes be extended to include as many species as possible. Therefore, a method of fixation and preservation applicable to field conditions is needed, since the methods hitherto employed are such that difficulty would be experienced in transporting the necessary solutions.

This paper offers a possible method, for in the experiments to be described material was fixed and preserved by a method so simple that its use is possible even on extended explorations. The idea which led to these experiments came by chance. In the fall of 1926 certain slides for routine laboratory work were prepared in the laboratory of the medical school of the University of North Carolina under the supervision of Dr. W. C. George. The material came from a 60 mm. opossum removed from the pouch, and showed many fine mitotic figures in various tissues. Several of these slides were sent to one of us (Hoy). These served later as a basis, together with other material, for a paper on the chromosomes of the opossum (Hoy and George, '29). From the standpoint of this present report the particularly interesting fact in connection with the study of the opossum chromosomes was that Dr. George had fixed and preserved the opossum by simply opening the body cavity and dropping the entire specimen into a bottle of Bouin's solution, in which it remained for several months.

The idea was then conceived of testing out the fixation method on not only another form but also on testicular material. Some species was required in which the chromosomal configuration was known so that comparisons could be made. For this purpose the house mouse (*Mus musculus*) seemed appropriate, since the chromosomes had been well worked out by Miss Cox ('26).

Accordingly, on Oct. 11 and 18, Nov. 19, and Dec. 8, in 1927, and on Jan. 14, in 1928, mice, obtained in live traps, were anesthetized, and the testes were removed and placed in Bouin's solution. The actual study of this material began in February, 1931, and was continued through April. Thus the tissue was subjected to an immersion of from a little over three to fully three and one-half years. This, certainly, is a much longer time than would be required even on extended field explorations.

The formula of Bouin's solution used in these experiments calls for 75 cc. of a saturated aqueous solution of picric acid, 20 cc. of 100 per cent formalin (40 per cent formaldehyde), and 5 cc. of glacial acetic acid. Two necessary precautions need to be followed. First, the material to be fixed must be absolutely fresh, i.e., if the animal is killed, not more than a few seconds should elapse between death and the fixation of the tissues, or if the animal is anesthetized, transfer of tissues from the body of the individual to the solution must be made as rapidly as possible. Second, in the case of testicular material, the tissue should be teased apart in the solution. If embryos are to be fixed, the body cavity should be opened.

In testing the value of this prolonged immersion in Bouin's as a fixation and preservation method the experimental results have been carefully checked with the findings reported by Miss Cox. She used an approved method of fixation (see Painter, '24), but one which does not readily lend itself to conditions in the field.

THE SPERMATOGONIAL CHROMOSOMES

Miss Cox reported 40 chromosomes. These represent 20 pairs. Between the largest and the smallest pairs she reports and illustrates a "gradual seriation." One of the pairs consists of two unequal chromosomes, one large, and one small. This is the x-y pair, concerned in the determination of sex. In text figure 1, a, is a drawing of a polar view of an equatorial plate obtained from the experimental material. For the sake of clearness a number of the superimposed chromosomes were drawn out of position. Forty chromosomes are present, and they show the "gradual seriation" in size. Such polar views were rare in the material examined. For the study of the shape and size of the chromosomes the pre-equatorial prophases are excellent, and they were fairly abundant.

THE CHROMOSOMES OF PRIMARY SPERMATOCYTES

Polar and side views of the first maturation spindle were described by Miss Cox. There are 20 tetrads on the spindle. Side views of the spindle show the characteristic shapes assumed by these bivalent chromosomes. Because of the precocious division of one of the tetrads, called "q," the number of chromosomes appearing in the equatorial plate is 21. Side views of the spindles show the same "gradual seriation" is size of the chromosomes as was the case in the spermato-

gonia. Six of the tetrads are "hat-shaped," four are "much elongated," two are small "hat-like," and frequently appear as "derby hats." In addition there are "diamond-shaped," and "dumbbell-shaped" tetrads, and lastly, the x-y pair, the y being next to the smallest in size.

Fig. 1, b, shows a pre-equatorial prophase with the 20 tetrads, six of which are drawn out of position, and Fig. 1, d, shows ten of the tetrads from side views of various spindles. It will be noted that the shapes coincide in general with those described by Miss Cox. One thing noted was the presence of a fairly large cross-shaped tetrad. No such shape is described by Miss Cox. It is possible that this is described by her as one of the larger diamonds. Fig. 1, c, is drawn from a polar view of the first maturation division. Chromosomes are seen to the number of 21, this number being due apparently to the precocious division of one of the tetrads.

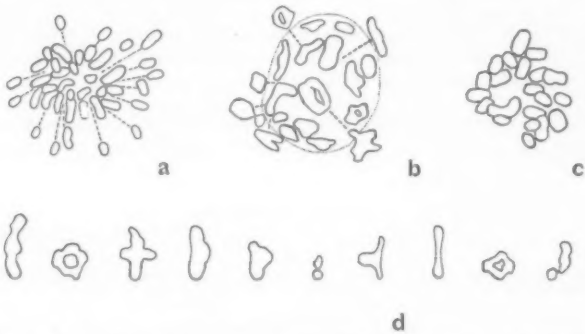

FIG. 1. *a*, Polar view of equatorial plate, spermatogonium. *b*, Late prophase, 1st maturation. *c*, Polar view of equatorial plate, 1st maturation. *d*, Tetrads from side views of various 1st maturation spindles. All drawings made with camera lucida. Reduced here one-half. Zeiss apochromatic 2 mm. obj., and compensating ocular 30 X.

The analysis of chromosome groups from this experimental material leads to the conclusion that the tissue is very well fixed and preserved for such study. Some sections, of course, show poor fixation in certain tubules, but this is the result with almost all of the fixation methods when applied to testicular material. One observation, which was repeatedly made, was the sharpness with which centrosomes and spindle fibers stood out in many of the mitotic figures. The spiral filament of the mature spermatozoa also appeared with great distinctness.

The method of fixation herein described is not new, though the experimental results on mammals is new. In the Handbook of Microscopical Technique, edited by Dr. C. E. McClung, the statement is made (p. 425) in discussing the use of certain modifications of Bouin: "Material may be left in them for long periods of time without danger of overfixation . . . . it has been found in the case of Orthopteran material that whole animals which have been opened sufficiently

for it [the solution described] to enter readily, may be so treated that the intimate cytological details of the cells, the germ cells particularly, are well preserved. This is a very great convenience when rapid preparation in the field is necessary."

Since this method is equally applicable to the tissues of opossum young and to the testes of mice, its further use for other marsupial and rodent material is suggested, and the probability is that it can be used successfully for other mammals. That it lends itself to field conditions can readily be appreciated.

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A DIET FOR CHIMPANZEES AND MONKEYS IN CAPTIVITY

By O. L. Tinklepaugh

The nutritional care of infra-human primates is becoming a problem of increasing importance with the growing number of laboratories and zoölogical gardens in which these animals are being kept for scientific and exhibition purposes. While participating in the care and maintenance of the chimpanzees at the Laboratories of Comparative Psychobiology, Yale University, the writer has developed a special cracker which, with suitable supplementary foods, has proved economical and satisfactory in feeding both these animals and monkeys of various species.[1] While this cracker is yet to be improved, the formula and analysis of it and supplementary foods are published in the hope that

[1] Both the Laboratories and the writer acknowledge indebtedness to Professors Lafayette B. Mendel and George R. Cowgill for valuable advice and suggestions. The writer expresses also his appreciation of the coöperation of Dr. Harold C. Bingham during the investigation.

they may be of value to others and at the same time lead to beneficial suggestions or criticisms. The formula for the cracker is as follows:

INGREDIENTS	GRAMS	PERCENTAGE
Graham flour	1,200	12.0
Cracked wheat	2,200	22.1
Corn meal	2,200	22.1
Rolled oats	1,000	10.0
Bone ash	350	3.5
Whole milk powder	400	4.0
Table salt	50	.5
Peanut butter	1,200	12.0
Raisins (ground)	920	9.2
Molasses (dark)	455	4.6
	9,975	100.0

This formula was arrived at after experimentation with various food materials. The ingredients were chosen on the basis of acceptability

TABLE 1

Analysis of Chimcracker

MATERIAL	PROTEIN		CARBOHYDRATE		FAT	
	Grams	Calories	Grams	Calories	Grams	Calories
Graham flour	159.60	638.4	856.8	3,427.2	26.40	237.6
Cracked wheat	244.20	976.8	1,661.0	6,644.0	37.40	336.6
Corn meal	202.40	809.6	1,658.8	6,635.2	41.80	377.2
Rolled oats	161.00	644.0	675.0	2,700.0	72.00	648.0
Bone ash						
Whole milk powder	148.28	593.1	200.16	800.6	8.92	80.3
Table salt						
Peanut butter	351.60	1,406.4	205.20	820.8	558.00	5,022.0
Raisins	23.92	95.7	700.12	2,800.5	30.36	273.2
Molasses	10.92	31.0	315.32	894.0		
Total	1,301.92	5,195.0	6,272.40	24,722.3	744.88	6,974.9

Total calories	36,892.2 or 4.42 per gram.
Protein calories	5,195.00 or 14.0 %
Carbohydrate calories	24,722.3 or 67.0 %
Fat calories	6,974.9 or 18.9 %

to the animals, economy, the consistency of the final product, and the necessity of a satisfactory protein, fat and carbohydrate content. Bone

ash affords a source of mineral elements and also partially allays the diarrheal condition frequently experienced with apes and some monkeys. Raisins and molasses contribute to the mineral and sugar content and increase the acceptability of the product to the animals.

Analysis of the formula is given in Table 1. There are reasonable proportions of proteins, carbohydrates and fats. The protein content

TABLE 2

Analysis of daily supplements

MATERIAL	PROTEIN		CARBOHYDRATE		FAT	
	Grams	Calories	Grams	Calories	Grams	Calories
Cabbage, 600 gms.	9.60	38.4	33.60	134.4	1.80	16.2
Carrots, 700 gms.	7.70	30.8	65.10	260.4	2.80	25.2
Onions, 500 gms.	8.00	32.0	49.50	198.0	1.50	13.5
Bananas, 1200 gms.	15.60	62.4	264.0	1,056.0	7.20	64.8
Oranges,‡ 2 per day, 350 grams.	*2.80*	*11.2*	*40.60*	*162.4*	*.70*	*6.3*
Apples, 2 per day, 320 gms.	*1.28*	*5.1*	*45.44*	*181.8*	*1.60*	*14.4*
Orange-apple*	2.04	8.2	43.02	172.1	1.15	10.4
Whole milk 1 cup†	4.95	19.8	7.50	30.0	6.00	54.0
Peanuts, 114 gms.	29.41	165.12	27.82	156.2	44.00	247.0
Total	77.30	356.7	490.54	2,007.1	64.45	431.0

Total calories.....2,794.7 or 4.42 per gram
Protein calories..... 356.6 or 12.8%
Carbohydrate calories.....2,007.1 or 71.8 %
Fat calories..... 431.0 or 15.4%

‡ Figures in italics are not included in the total. The figures following orange-apple represent the composite of these two, that is the 2.04 grams of protein represents the sum of 2.80 and 1.28 divided by 2, and this amount is added to the total.

* Calculated on basis of average for 2 oranges or 2 apples, equivalent to 1 orange plus 1 apple per day. One orange equivalent to 175 grams, edible portion. One apple equivalent to 160 grams, edible portion.

† Based on one cup whole cow's milk at 150 grams.

is slightly low, but this is partially compensated for in our laboratories by the supplementary foods, part of which are used as lures or rewards in our investigations. The fat calories might be increased, though the desirability of this for animals in captivity is questionable.

The completed product, as used in our laboratories, is prepared for

us by a commercial bakery[2] under the name chimcracker.[3] It is provided in the form of dry, hard biscuits two and one-half by three inches on the sides by one-half inch in thickness. The cracker, in lots of one-half ton or more, has cost us ten to twelve cents a pound.

Typical supplementary foods such as we have used in both raw and cooked forms in our care of the chimpanzee are enumerated and analyzed in Table 2. Suitable substitutes can be found for practically any of them. The ones listed are ordinarily available at reasonable prices in

TABLE 3

*Daily food per adult chimpanzee**

FOOD	PROTEIN		CARBOHYDRATE		FAT	
	Grams	Calories	Grams	Calories	Grams	Calories
Chimcracker	81.0	324	372	1,488	48.5	436
Supplements: Cabbage, carrots, onions, banana, peanuts	39.6	205.9	130.8	568.2	47.3	276.7
Apple and orange and milk	7.0	28	50.5	202	7.2	64.8
Total	127.6	557.9	553.3	2,258.2	103.0	777.5

Total calories per animal per day	3593.6
Protein calories in percent	15.5%
Carbohydrate calories in percent	62.8%
Fat calories in percent	21.6%

* This table is based on the daily consumption of four chimpanzees during the cold winter months. The individual weights of the four animals varied from 22 to 35 kilos; the total weight of the four was 109 kilos. The subjects were confined in an outdoor cage approximately 10 feet wide by 30 feet long, and had constant access to a large living room. In smaller quarters, or during warmer weather, their food consumption would undoubtedly have been less.

this country and provide a combination of foods by the variation of which the eliminatory functions of the animals can usually be controlled. This applies particularly to apples and onions, both of which have a fairly marked laxative effect.

In Table 3 is shown the total food consumption per adult chimpanzee, determined with the use of the chimcracker and the foods enumerated in the supplementary list.

For two years the chimcracker or its equivalent has served as the

[2] Potter Wrightington, Inc., Boston, Massachusetts.

[3] Name suggested by David N. Yerkes.

principal item of diet for the adolescent and mature chimpanzees at the Yale Laboratories. For over a year it was used also with three monkeys. In the meantime it has been used on a smaller scale by other laboratories in feeding both apes and monkeys. Our own results and those of others, so far as we have been informed, have shown it to be a thoroughly satisfactory food, economical in use and acceptable alike to both chimpanzees and various species of monkeys. In the Yale laboratories its use has resulted in the almost complete elimination of flatulence in the chimpanzees, due apparently to the animals' inability to bolt the cracker as is their custom with softer foods, and to the relatively high gram-calorie content which reduces the bulk of the food consumed. At the same time the feces have become more firm. The dry, hard cracker requires mastication in the course of its consumption, and this has resulted in improvement in dentition and in the condition of the oral cavity in general. In addition the cracker provides a ready prepared, adequately balanced food item, which is easily kept and which can be fed without waste or nuisance.

Laboratories of Comparative Psychobiology, Yale University.

A NEW POCKET GOPHER FROM ILLINOIS AND INDIANA

By E. V. Komarek and Don A. Spencer

[*Plate 14*]

In making a survey of the mammals of Illinois for the Chicago Academy of Sciences during the past three years, the writers collected forty-seven *Geomys* in Illinois and Indiana. These, according to the literature on the mammals of these states, were supposed to be *Geomys bursarius* Shaw, but upon comparing their specimens with Merriam's (1895) description, the writers became skeptical. According to Merriam, typical *bursarius* should be "dark liver brown or chestnut above and below, somewhat paler on the belly (belly very rarely whitish)." The pocket gophers taken were distinctly *slate-gray* with a faint wash of light brown or white on the belly. Upon closer examination, and comparison with specimens of *Geomys bursarius* from Iowa, Minnesota, Missouri, Kansas, North Dakota, South Dakota, and Wisconsin, sufficient differences were found to warrant separation of the Illinois and Indiana animal as a new subspecies.

Merriam (1895) does not record any specimens *examined* from Illinois or Indiana, but states that the pocket gopher is found in these States. The history of *Geomys bursarius* Shaw is so uncertain that it is very doubtful if the type is in existence (Merriam 1895), and the type locality given is no more definite than Upper Mississippi Valley. Accordingly, the specimens taken by the writers were compared with forty-nine skins and skulls from the above-mentioned states. This examination confirmed our earlier conclusion, that the Illinois-Indiana *Geomys* constitutes a new subspecies.

The writers wish to express their appreciation of the helpful assistance, criticism, and suggestions given them, especially to Mr. A. M. Bailey, Director of the Chicago Academy of Sciences, Dr. W. C. Allee, University of Chicago, Dr. W. H. Osgood, Field Museum of Natural History, and Dr. H. H. T. Jackson, of the U. S. Biological Survey, and to the U. S. Biological Survey and the Milwaukee Public Museum for the loan of specimens.

Geomys bursarius illinoensis, new subspecies

Illinois Pocket Gopher

Type.—Male adult, No. 713, Chicago Academy of Sciences; taken in brown, sandy loam soil, one mile south of Momence, Kankakee County, Illinois, July 15, 1930; collected by E. V. Komarek and D. A. Spencer; original number, K-567.

Diagnostic characters.—As compared with *Geomys bursarius* Shaw, (from Iowa, Minnesota, North Dakota, Missouri, South Dakota, and Wisconsin), color distinctly *slate-gray* with no trace of brown or brownish on back; hairs tinged with light brown or white on belly; nasals constricted medially, somewhat hour-glass shaped; superficial canals on palatine only extending to first molar, and from there more or less fused. Cranial characters otherwise apparently identical with *bursarius*. Size large; measurements of 25 specimens in flesh: Males: Total length, 265–322 mm.; tail, 88–98 mm.; hind foot, 32–36 mm. Females: Total length, 253–273 mm.; tail, 69–73 mm.; hind foot, 32–35 mm.

Description of type.—Coloration distinctly *slate-gray* above; belly hairs slate-gray, tipped with light brown or white; tail scantily covered with whitish hairs, darker near base; small white spot on the throat (all specimens examined have this spot); nasals constricted medially, somewhat hour-glass shaped (see Figure 1); superficial canals on palatine extending only to first molar.

Distribution.—This pocket gopher appears to be well isolated from *Geomys bursarius* Shaw, as shown on map. Robert Kennicott (1858) remarked about this distribution: "East of the Mississippi it has been found in some parts of Indiana, Michigan, and Wisconsin; and on the great prairies, in central Illinois; also south and east of the Illinois River it is constantly met with. It is worthy of remark, if true as alleged, that the part of Illinois lying between the Illinois River and the Mississippi is entirely free from gophers, while they are abundant along the borders of the opposite sides of these rivers."

Specimens examined.—Forty-seven *Geomys bursarius illinoensis* collected by the writers at Momence, St. Anne, Custer Park, Hopkins Park, Kankakee, Ottawa, Utica, Beaverville, and La Salle, Illinois; and Lake Village and Thayer, Indiana. Eleven skins and skulls from Clinton and Havana, Illinois, loaned through the courtesy of the U. S. Biological Survey. Three old mounted specimens from Lacon, Illinois, at the Chicago Academy of Sciences. One mounted specimen from Champaign County, Illinois, at the University of Illinois Museum. One mounted specimen from Lacon, Illinois, at the Field Museum. A total of 63 specimens from Illinois.

Geomys bursarius bursarius from Burnett, Pierce, Douglas, and Buffalo counties, Wisconsin, loaned through the courtesy of the Milwaukee Public Museum. Thirty specimens from Iowa, Minnesota, South Dakota, North Dakota, and Missouri, loaned through the courtesy of the U. S. Biological Survey.

Pocket gophers taken near Beaverville, Iroquois County, Illinois, on February 8, 1931, were in changing pelage. The winter coat is longer and much lighter in color. Two specimens taken at the type locality on the same date, also were of a lighter slate color, but no trace of brown was found on any of the gophers.

Remarks.—J. A. Allen (1869) remarks on the species: "Whether or not large rivers form impassable barriers to it [the pocket gopher], it seems to be well substantiated that while this animal occurs on the Iowa side of the Mississippi River and in central Illinois, or throughout that part of the latter state south and east of the Illinois River, it does not exist in that portion situated between the Illinois and the Mississippi. Mr. Kennicott refers to his having heard this reported, but was unable to vouch for the truthfulness of the account. When in this section of Illinois, however, I was repeatedly informed by competent and trustworthy observers who had resided in this part of the state since its first settlement, and who had traversed it extensively, that the pocket gopher did not exist in that portion of Illinois between these rivers. This fact seems the more strange when we remember that the gopher is common in portions of Wisconsin, being, in fact, very numerous in Winnebago and Fond du Lac counties, as I myself, have ascertained." Howell (1910) remarks about the southern range as follows: "It * * * was found to occur very sparingly at Coulterville, Woodlawn, and Odin, and a few miles north of Olney. It does *not* occur on the prairie about Duquoin, so that Coulterville is considered to be about the southern limit in the state [Illinois]." Cory (1910) records a specimen in the Field Museum from Anderson, McCoupin County, Illinois.

We have not been able to find any record of specimens taken in Indiana previous to our collecting, but Hahn, in 1908, writes as follows: "I have never collected it in Indiana, nor do I know of any specimens from the state in collections, but there is no doubt of its occurrence in Lake and Newton Counties. The only definite records I have are Shelby, Lake County, and Lake Village, Newton County." Evermann and Butler (1894) also remark on its occurrence in Newton County, Indiana, but obtained no specimens. The present writers obtained specimens in east central Illinois and in Newton County, Indiana, during 1930. The Indiana specimens appear to be the first actual specimens recorded from that state, so far as the writers were able to ascertain from the literature and correspondence with institutions and individuals.

The Illinois pocket gopher is found living in the brown, sandy loam areas in

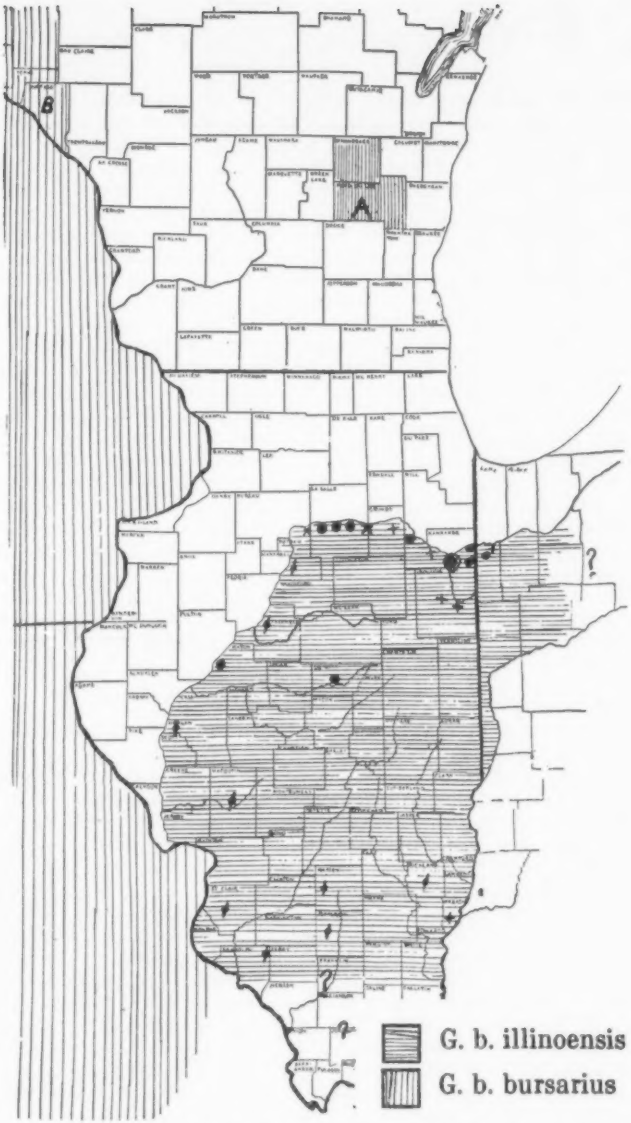

FIG. 1. A. Geomys recorded by Merriam (1895), but no specimens mentioned. B. Specimens from Wisconsin examined by the authors. ●. Specimens of Geomys examined from Illinois and Indiana. ✐. Other specimens of Geomys. +. Activities of Geomys observed by authors.

central Illinois and northwestern Indiana. In fact, on soil maps the brown. sandy loam areas appear to be correlated with the distribution of this subspecies within the region bounded by the Mississippi, Illinois, Kankakee, and Wabash Rivers. Momence seems to be the northern limit of its range. This supposed distribution, if correct, may be caused by two factors: (1) The Kankakee River may act as a barrier, since no pocket gophers or evidence of their activities were observed north of this river; (2) the soil immediately north of the Kankakee River is not of the brown sandy loam; this is found much farther north. The region north of the Kankakee River, that is, northeastern Illinois and southeastern Wisconsin, was very thoroughly worked over by the writers in a mammalian survey from August, 1928, to October, 1930.

After a diligent search, we were unable to find pocket gophers south of the Kankakee River in the vicinity of Hoopeston and Danville, Illinois. Not any were observed in southern Illinois in Johnson, Pope, Pulaski, and Massac Counties, which fact appears to bear out Howell (1910) that Coulterville, Illinois, is the southern limit of distribution.

Komarek has trapped in southeastern Wisconsin, and never observed any pocket gophers in that section. Mr. Earl G. Wright, Chicago Academy of Sciences, who has lived in southeastern Wisconsin most of his life, states that he has never seen or heard of any *Geomys* in that part of the state. It appears that specimens from Fond du Lac County, recorded by Merriam (1895), are the southernmost records in that state.

The accompanying map shows the range of *Geomys* in Illinois, Indiana, and Wisconsin, based on actual specimens. All specimens of pocket gophers examined from Illinois and Indiana are slate-gray in color, while all those of Wisconsin appear to be *Geomys bursarius* Shaw.

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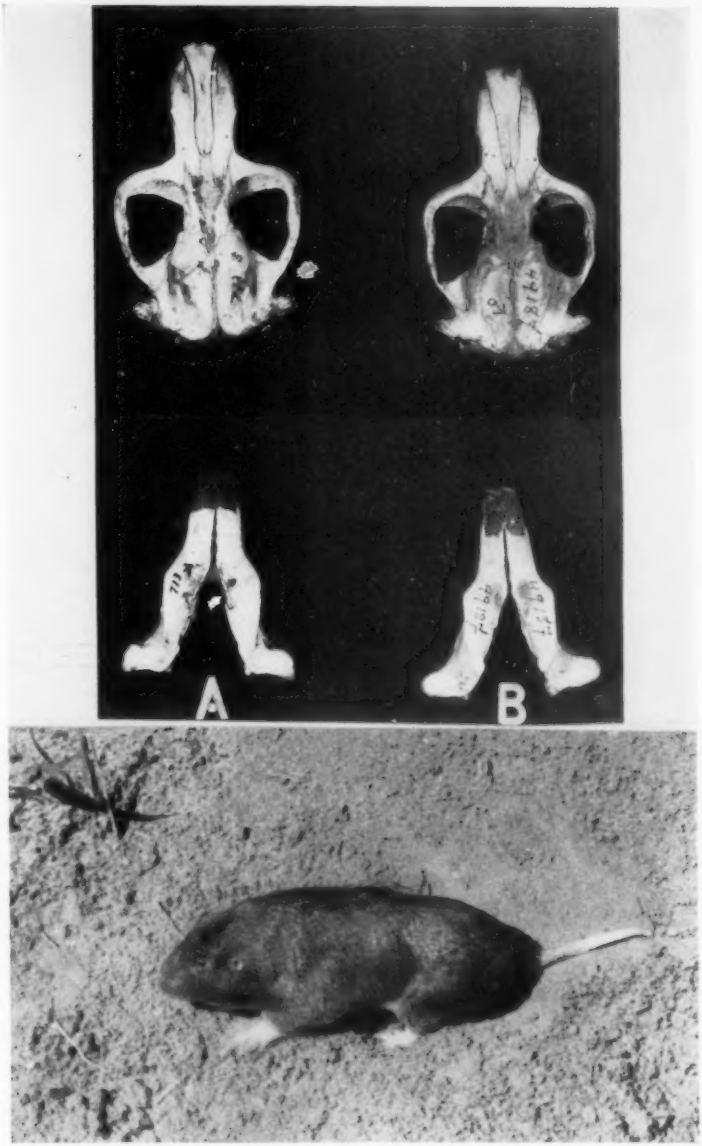
The Chicago Academy of Sciences and The University of Chicago



UPPER. **A.** Geomys bursarius illinoensis, new subspecies. Type, male, No. 713, Chicago Acad. Sci.; Momence, Illinois; July 15, 1930. **B.** Geomys bursarius bursarius Shaw. Male, No. 49187, U. S. National Museum, Biological Survey Coll.; Portland, N. D.; October 26, 1892.

LOWER. Geomys bursarius illinoensis, new subspecies. Photographed at St. Anne, Illinois, on July 15, 1930 (from motion picture film by the authors).

THE RED BATS OF THE GREATER ANTILLES

By Gerrit S. Miller, Jr.

Bats of the genus *Lasiurus*[1] have long been known to occur in Cuba. That they inhabit other islands of the Greater Antilles is a fact that seems to have almost escaped record. In the U. S. National Museum there is the skin of an immature individual collected by W. F. March at Spanishtown, Jamaica, probably in 1868 (catalogued April 10, 1869) and mentioned in my account of the genus published in 1897. There are also three adults from the same island, District of Vere, received from the Institute of Jamaica in 1898. The National Museum likewise contains four skulls found in owl pellets recently brought by Mr. H. W. Kreiger from a cave in southern Haiti.

Though the genus *Lasiurus* is thus shown to occur on three of the four main Greater Antillean islands it apparently has not yet been found on Porto Rico. Mr. H. E. Anthony does not list it in his Mammals of Porto Rico, Living and Extinct—Chiroptera and Insectivora (New York Acad. Sci., Scientific Survey of Porto Rico and the Virgin Islands, vol. 9, pt. 1, 1925) and I have been unable to discover records or specimens elsewhere.

When the Cuban, Jamaican and Haitian specimens are compared with each other and with red bats from the eastern United States it is at once apparent that each island is inhabited by a form distinct from all the others. These forms are distinguished by such well defined characters that overlapping through individual variation seems improbable. I prefer, therefore, to use binomial names for them despite the fact that they are doubtless all local derivatives from one widely distributed stock.

Lasiurus pfeifferi (Gundlach)

1861. *Atalapha pfeifferi* Gundlach, Monatsber. k. preuss. Akad. Wissensch. Berlin, p. 152. (Cuba).

1897. *Lasiurus borealis pfeifferi* Miller, North Amer. Fauna, no. 13, p. 110, October 16, 1897.

Characters.—Differs from the red bat of the eastern United States in larger size (forearm 42 mm. or more instead of 42 mm. or less; tibia about 21 mm. instead of 18.6–20 mm.), and in the marked reduction of the pale hair tips on both upper

[1] Gray, 1831, Zool. Miscellany, no. 1, p. 38, type, *Vespertilio lasiurus* Schreber = *V. borealis* Müller. Under suspension of rules the International Commmission of Zoological Nomenclature has set aside the earlier generic name *Nycteris* Borkhausen, 1797 (see Opinion 111, Smithsonian Misc. Coll., vol. 73, No. 6, p. 18, June 8, 1929).

and lower surfaces of body. Skull equal in size to that of the largest individuals of *L. borealis borealis*.

Measurements.—Two adult males (Nos. 4908 and 4909 Amer. Mus. Nat. Hist.): Head and body, 55, 54; tail, 49, 48; tibia, 21.2, 21; foot, 8.0, 7.0; forearm, 44, 42; thumb 7.0, 7.6; third finger, 89, 90; fifth finger, 54, 55; ear from meatus, 10, 11; width of ear, 10, 11; greatest length of skull, 13.8, 13.6; condylobasal length, 13.2, 13.0; zygomatic breadth,—, 10.0; interorbital constriction, 4.6, 4.8; breadth of braincase, 7.6, 7.8; depth of braincase, 6.0, 6.4; mandible,—, 9.6; maxillary toothrow, 5.0, 4.8; mandibular toothrow, 5.0, 5.2.

Specimens examined.—Two, both from Trinidad, Cuba (American Museum of Natural History).

Lasiurus degelidus sp. nov.

Type.—Adult female (in alcohol) No. 96187, U. S. National Museum. Sutton's District of Vere, Jamaica. Received from the Institute of Jamaica in 1898.

Characters.—Skull in two females larger than in two males of *Lasiurus pfeifferi* and cheekteeth (in crown view) conspicuously larger. Color of females about as in brightest males of *Lasiurus borealis borealis* but with no trace of grayish "frosting" on upperparts; underparts darker than in the mainland animal, and, in two of four specimens, with no whitish tips on the hairs of the chest, the white shoulder spots thus thrown into very strong relief.

Measurements.—Type and a second adult female (No. 96187): head and body, 57, 53; tail, 53, 52; tibia, 22, 21; foot, 7.6, 8.0; forearm, 45, 45; thumb, 8.0, 8.2; third finger, 94, 93; fifth finger, 61, 60; ear from meatus, 13.2, —; width of ear, 11.4, 11; greatest length of skull, 14.2, 14.0; condylobasal length, 13.6, 13.4; zygomatic breadth, 10.0, 10.0; interorbital constriction, 4.8, 4.6; breadth of braincase, 8.0, 7.8; depth of braincase, 6.0, 6.0 mandible, 10.8, 10.4; maxillary toothrow, 5.0, 4.8; mandibular toothrow, 5.6, 5.6

Specimens examined.—Four, all from Jamaica (one taken at Spanishtown, the others from the District of Vere).

Lasiurus minor sp. nov.

Type.—Skull with complete set of molariform teeth (but lacking canines, incisors and mandible) No. 256505, U. S. National Museum. From owl pellets collected by H. W. Krieger in the "Voute l'Église," a cave situated near the Jacmel road a few kilometers north of Trouin, Haiti, March 6–7, 1931. Altitude, 1350 feet.

Characters.—Skull noticeably smaller than that of the Cuban or Jamaican species, its size about the same as in ordinary specimens of *Lasiurus borealis borealis* from Virginia; braincase, as compared with that of the mainland animal, more rounded when viewed from above, and more flat-topped when viewed from behind; lacrimal ridge and tubercle poorly developed; upper cheekteeth essentially like those of *L. borealis borealis* except that pm^4 is smaller. External characters unknown.

Measurements.—Type and a second specimen (No. 256507) from the type locality: Greatest length of skull, 13.0, 12.0; condylobasal length, 12.2, —; zygomatic breadth, 9.2, 9.0; interorbital constriction, 4.6, 4.6; breadth of braincase, 7.6, 7.0; depth of braincase, 6.0, —; maxillary toothrow, 4.2, 4.0.

Specimens examined.—Four skulls from the type locality.

Division of Mammals, United States National Museum.

TWO NEW SOUTH AMERICAN BATS

By Gerrit S. Miller, Jr.

Among the South American bats in the collection of the U. S. National Museum I find representatives of the following two forms that appear to have not been hitherto described.

Lichonycteris degener sp. nov.

Type.—Adult female (skin and skull) No. 239520, U. S. National Museum. Collected at Para, Brazil, July 22, 1923, by C. R. Aschemeier.

Characters.—Differs from *Lichonycteris obscura* Thomas, as represented by a specimen from Dutch Guiana, in the more degenerate condition of the cheekteeth; premolars more widely spaced; m_1 and m_2 with transverse diameter through posterior segment not greater than that through anterior segment.

Measurements.—Type: Tibia, 11.6; foot, 8.6; 3d finger, 61; fifth finger, 47; ear from meatus (dry), 10.6; greatest length of skull, 19.0; condylobasal length, 18.4; interorbital breadth, 3.8; breadth of braincase, 8.4; depth of braincase, 6.8; mandible, 13.4; maxillary toothrow, 6.2; mandibular toothrow, 6.4.

Specimen examined.—The type.

Remarks.—In naming this animal I am assuming that the specimen from Dutch Guiana represents *Lichonycteris obscura*, the type of which came from Nicaragua. The most obvious single character of the Brazilian species is the reduced condition of the posterior segment of the lower molars. This segment in *L. obscura* is decidedly broader than the anterior segment. In color the type specimen differs from the Guianan skin in the less yellowish suffusion of the entire pelage: underparts hair-brown instead of mars-brown; hairs of back ecru-drab with dark sepia tips instead of pale wood-brown with bister tips.

Thyroptera discifera major subsp. nov.

Type.—Adult female (skin and skull) No. 105419, U. S. National Museum. Collected at San Julian, Venezuela, July 17, 1900, by Wirt Robinson and M. W. Lyon, Jr.

Characters.—Like the Central American *Thyroptera discifera discifera* (Peters and Doria) but larger (forearm in five adults ranging from 34.6 to 35.4 as compared with 30 and 31 in two adults from Nicaragua; tibia 15.4 to 16.2 as compared with 13.6 and 14.6; greatest length of skull, 14.2 to 14.6 as compared with 13.4).

Measurements.—Type: Head and body, 48 (37.6);[1] tail, 28 (26); tibia, 15.8 (13.6); foot, 5.2 (4); forearm, 35.4 (31); third finger, 62 (69); fifth finger, 48 (41.6); greatest length of skull, 14.6 (13.4); condylobasal length, 13.0 (12.4); zygomatic breadth, 7.0 (6.8); interorbital constriction, 2.6 (2.4); breadth of braincase, 6.8 (6.6); depth of braincase, 5.4 (5.2); mandible 10.6 (10.2); maxillary toothrow, 5.8 (5.6); mandibular toothrow, 6.0 (5.8).

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[1] Measurements in parenthesis are those of an adult female *T. discifera discifera* from Escondido River, Nicaragua (No. 51538).

Specimens examined.—Eleven, all from the type locality.

Remarks.—In reporting on the collection of which this bat forms a part Robinson and Lyon mentioned the large size of the Venezuelan *Thyroptera discifera* as compared with the specimens from Nicaragua.[2] For reasons that now seem insufficient they refrained from formally separating the two races.

Division of Mammals, United States National Museum.

[2] Proc. U. S. National Museum vol. 24, pp. 155–156. October 3, 1901.

TWO NEW MAMMALS FROM CELEBES

By Gerrit S. Miller, Jr.

Further examination of the mammals obtained in Celebes by H. C. Raven shows that among them there are two, a bat and a black ape, that have not yet been described.

Phoniscus rapax sp. nov.

Type.—Adult male (in alcohol) No. 199834, U. S. National Museum. Collected at Paleleh, north coast of northeastern Celebes (about latitude 122°), August 25, 1914, by H. C. Raven. Original number 1670.

Characters.—Similar to the small Sumatran *Phoniscus atrox* and the large Javan *P. javanus* but intermediate in size; general form of skull less elongate than in the related species, the rostrum shorter in proportion to the inflated, deepened braincase. Teeth with no marked peculiarities; i_1 with a small but obvious fourth cusp.

Measurements.—Head and body 49; tail, 37; tibia, 17.0; foot, 8.0; forearm, 35; thumb, 8.6; third finger, 73; fifth finger, 56; ear from meatus, 14; width of ear, 14; tragus, 8; greatest length of skull, 16.0 (14.8)[1]; condylobasal length, 14.6 (13.2); zygomatic breadth, 9.6, (9.0); interorbital constriction, 4.0 (4.0); breadth of braincase, 7.8 (7.2); depth of braincase, 7.0 (6.2); mandible, 11.4 (10.4); maxillary toothrow, 6.4 (6.0); mandibular toothrow, 7.0 (6.2).

Specimen examined.—The type.

Remarks.—As might have been expected, the Celebean *Phoniscus* proves to be distinct from the species inhabiting Java and Sumatra. Externally the three animals appear to be very similar to each other except in size; forearm in two *P. atrox* 34 and 35, in *P. rapax* 35, in three *P. javanus* 37.6–39; fifth finger in two *P. atrox* 47 and 49, in *P. rapax* 56, in three *P. javanus* 56–57; lower leg in two *P. atrox* 22.6 and 23, in *P. rapax* 25, in three *P. javanus* 27.4–28; greatest length of skull in two *P. atrox* 14.8 and 15.0; in *P. rapax* 16.0, in three *P. javanus* 16.4–17.2.

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[1] Measurements in parenthesis are those of the type of *Phoniscus atrox*.

Cynopithecus lembicus sp. nov.

Type.—Adult male (skull only) No. 217573 U. S. National Museum. Collected on Pulo Lembeh, northeastern Celebes, May 30, 1916, by H. C. Raven. Original number 2471.

Characters.—Similar to *Cynopithecus niger* of the nieghboring Celebean mainland but smaller: Greatest length of skull in three adult males, 125.2, 125.4 and 125.9 as compared with 143.3 and 144.5 in two adult males of *C. niger*; greatest length of skull in three adult females 111, 112.6 and 113 as compared with 124.5 and 128.6 in two adult females of *C. niger*.

Color.—The color does not differ appreciably from that of *Cynopithecus niger*. In an adult male from Pulo Lembeh (No. 217563) it has the effect of being everywhere essentially black, though the fur of the back and sides is drab beneath the surface, and this lighter color is evident when the skin is viewed from behind. The only entirely black fur is on the underparts. Outer surface of arm always grizzled by dull light gray annulations. These sometimes extend downward nearly to the wrist. In some skins a few are visible across the shoulders in certain lights. The drab under color (which sometimes, especially in females, permeates the pelage except on the hands and feet) and the grizzled area on the outer side of the arm are two features of the coloration of *Cynopithecus niger* that appear to have been generally overlooked.

Measurements.—Type: Head and body,[2] 520; foot,[2] 165; greatest length of skull, 125.4 (143.3);[3] condylobasal length, 96.7 (112.0); zygomatic breadth, 80.6 (87.8); postorbital constriction, 42.5 (43.5); breadth across middle of both orbits, 61.0 (70.5); interorbital constriction, 5.5 (6.4); maxillary breadth at anterior base of zygoma, 58.4 (53.3); maxillary breadth across canines, 41.3 (44.6); breadth of braincase, 62.6 (64.6); height of braincase above backward projection of alveolar line, 59.6 (69.2); mandible, 97.4 (105.1); depth of mandible through coronoid process, 42.3 (51.0); maxillary toothrow including canine, 43.2 (47.8); maxillary molar-premolar series, 33.1 (34.5); mandibular toothrow including canine, 49.7 (55.4).

Specimens examined.—Six skins and nine skulls, all from Pulo Lembeh. For comparison the National Museum contains 18 skins and 22 skulls of *Cynopithecus niger* from Celebes proper.

Division of Mammals, United States National Museum.

[2] Collector's measurements; skin not received in Washington.

[3] Measurements in parenthesis are those of an adult male *Cynopithecus niger* (No. 217571) from Temboan, northeast Celebes (about latitude 124° 30′).

LOWER OLIGOCENE RHINOCEROSES OF THE GENUS TRIGONIAS

By Horace Elmer Wood, 2nd

Gregory and Cook (1928) recently published a very thoughtful and valuable paper on the remarkable *Trigonias* collection from the Lower Oligocene of Weld County, Colorado, now in the Colorado Museum of Natural History at Denver. As their paper presents its material in highly concentrated form, Professor Gregory suggested that I should undertake an evaluation of their results on the basis of my previous work on the genus (Wood, 1927), which covers all known specimens except those at Denver. A several days' visit to Denver in 1928 gave me an opportunity to study the collection described by Gregory and Cook, as well as a number of additional specimens collected too late to be included in their study. I was also privileged to visit the Weld County Quarry.

I wish to acknowledge my indebtedness to Professor W. K. Gregory for his suggestion that I undertake this study, as well as for his helpful criticism; to Mr. H. J. Cook, former Curator of Fossil Vertebrates at the Colorado Museum, for permission to study this material and to visit the "*Trigonias* Quarry," which is leased by the Museum; and to the staff of the Colorado Museum for their assistance during my visit. I am indebted to Dr. Florence Dowden Wood for the drawings, and to Mr. Albert Elmer Wood for assistance in making measurements, and in the partial development of a number of specimens.

The locality of the quarries is twenty-three miles northeast of New Raymer, by road, and fourteen miles north of Stoneham. The two quarries are closely adjoining, in Township 10 North, Range 57 West, Sections 26 (Lower Quarry) and 27 (Upper Quarry). The altitude is about 5000 feet. In an unpublished study of a sample of the Lower Quarry sediment, Mr. Arthur D. Howard finds a high proportion of volcanic shards to other identifiable minerals. Extensive kaolinization has obscured the character of most of the components, but he considers it strongly probable that the material represents an altered tuff. Wanless (1922) reports "occasional fragments of pumice and volcanic glass" throughout the Titanotherium and Oreodon clays of the Big Badlands Oligocene, but this sample would seem to be more predominantly volcanic, as is Wanless' sample from the Oreodon Beds of Lewis Creek, Colorado. There is no possible question that the Weld County Quarry

is of Chadron age. It is probably equivalent to an early phase of the typical Titanotherium Beds of the South Dakota Oligocene.

Gregory and Cook's general conclusion can best be quoted as follows (page 4):

"Indeed, if the series were less complete, were the specimens from different localities or horizons, and had we chanced also to find only the extremes of variation, we should have felt no hesitation, according to widely accepted standards in palaeontology, in describing at least seven 'new species' representing possibly three different genera; but these extreme differences are bridged over by numerous intergrading conditions and combinations of characters, so that one soon gets the impression, on the one hand, that the Weld County series reveals a highly plastic condition of the rhinoceros population from which natural selection might accentuate and stabilize the differences in the premolars so as to give rise to the different 'species' already known from the next higher horizon; on the other hand, that extensive hybridism between formerly distinct races was actively going on. . . . . While we thus incline to the hypothesis of extensive hybridism between originally distinct races, for the sake of convenience in describing and cataloging the material we nevertheless designate the various groups or individuals as variants or 'species' realizing full well that these terms in this instance, and perhaps in many others, merely signify a definable set of characters in certain individuals."

This conclusion, which is also illustrated in the series of graphs and tables, certainly accords with the evidence, and serves as a timely warning of the pitfalls of species making. It also is an evidence of the coming period of interpreting paleontologic data in the light of the background furnished by genetics.

Gregory and Cook's first alternative explanation of the causes of the intermingled characters seems the more probable—that incipient speciation was occurring. Some of these types seem to be leading to later and more distinct forms. There is no evidence in the Eocene of any "formerly distinct races" of *Trigonias* which might hybridize to produce the Weld County assemblage. Nor am I able to agree with the apparently implied assumption (page 4) that an area undergoing erosion is thereby less able to support life than one receiving sediments, and that, therefore, there is reason to assume that isolated geographic races of rhinoceroses extended their range with the resumption of sedimentation in the Chadron.

Starting from an essentially similar viewpoint as to the actual situation involved in the Weld County assemblage, Matthew (1930) takes a diametrically opposed view as to the desirability of giving taxonomic recognition to variants of this kind. He writes:

"We should not, in other words, expect to find two or more closely related species living together at the same time, within the same area, and with the same

habitat, causing their remains to be preserved together in the same quarry. We should expect to find that the individuals either intergrade or that the variations are distributed among different individuals in the manner that results from intercrossing of different breeds or strains. . . . . This is equally true of the Lower Oligocene rhinoceros *Trigonias*."

"There is every reason to believe on ecologic and other grounds that this series represents one genus and one species thereof, the wide range of variation in structure of the cheek teeth illustrating how little value should be attached to the complex detailed phylogenies with numerous species and many so-called genera, that have been built up on the comparison of numerous fragmentary specimens from various localities." (Matthew, 1931.)

This *Trigonias* material brings up the old question of what is a species, which the geneticist is hardly better able to answer than is the taxonomist. However, from the view-point of convenience, it is certain that some of these specimens are sufficiently different from the rest to require individual mention, and may, therefore, deserve individual designations. Obviously, we cannot be sure whether they would have been sterile *inter se*, or not, nor even whether sexual repugnance existed between them in life. Convenience is the only real criterion, especially in paleontology, for deciding whether or not to give taxonomic recognition to morphologically distinct variants. It is, at least, a tenable point of view that it is legitimate to name any variant sufficiently distinct to require individual discussion.

Study of the entire group of thirty-five skulls (excluding only those with the teeth too worn or too damaged to be of any interest) showed that they are all much of a size, even including the smallest, ?*Caenopus premitis*. Gregory and Cook's measurements confirm this impression. For example, the extremes in length of P^1–M^2 are 208 mm. and 175 mm. Such extremes for a normal curve of distribution would certainly not warrant specific distinction. Since all members of this assemblage of forms were much of a size, such "speciation" as was occurring was along qualitative, rather than quantitative lines. Again, although the skulls differ somewhat in proportion, the differences are very moderate indeed, particularly when the effects of crushing are allowed for.

Gregory and Cook's ingenious graphs are of considerable interest in showing the extent of variability in various characters, and the degree of correlation between different characters of the various individuals. The distribution of some of these characters seems entirely fluctuating; other characters tend somewhat to separate the individuals into groups. There is, however, always the danger in fitting material into such a formal plan that the verbal definition of a specimen may not give a true impression of its actual character.

By means of this extensive series of specimens, Gregory and Cook were able to settle a number of significant questions regarding tooth succession. They show that in *Trigonias* (and, presumably, in its various relatives) the enlarged lower tusk is the second incisor; that, probably, I_3 is lost before C_1; and that there is no succession in the case of the first upper premolar. This has long been regarded as the case with the first lower premolar. The positive demonstration that the lower tusk is I_2 is particularly interesting, in view of the fact that Stehlin (1930) has now definitely established the fact that in at least one European rhinoceros there are two incisors on each side, in front of the lower tusks, so that the enlarged tooth must be I_3 or C_1. This appeared to be the case in the type of *Epiaceratherium* (*Ronzotherium*) *gaudryi* (Rames), new combination, but some doubt was possible in regard to the interpretation of the right lateral incisor, which might have been considered a retained deciduous tooth. Stehlin's closely comparable specimen (which he calls *Engyodon* [=*Eggysodon*] sp. and which is probably conspecific with *Epiaceratherium gaudryi*) removes any question. As Stehlin pointed out, the size and erectness of the tooth is more suggestive of a canine than of an enlarged incisor; and there is no precedent for enlarged I_3^3 in rhinoceroses or other perissodactyls (except tapirs). Roman's data (1912), as well as unpublished evidence, would best fit with the view that the enlarged teeth are canines rather than third incisors. Considering all available data, it appears that *Epiaceratherium* belongs to a separate subfamily of true rhinoceroses, paralleling the Amynodontidae, with enlarged canines (or, barely possibly, I_3^3), and including the following described forms: *Ronzotherium gaudryi* Rames, *Eggysodon osborni* Roman (not of Schlosser), *Eggysodon pomeli* Roman, *Epiaceratherium bolcense* Abel, and *Epiaceratherium turgaicum* Borissiak. In spite of the general similarity of *Epiaceratherium* to other true rhinoceroses, this line must have split off from them at a very early stage, before I^1 and I_2 began to enlarge. This would add the new subfamily *Epiaceratheriinae* to the seven or so other subfamilies of true rhinoceroses. Matthew (1931) failed to recognize the clear demarkation of *Epiaceratherium* from all other true rhinoceroses, in having C_1^1 enlarged, instead of I^1 and I_2, but his opinion that it was close to the other Oligocene rhinoceroses was warranted by the data known to him. Further discussion of the relationships and valid species of this group is reserved for a separate paper on the earlier European rhinoceroses.

Generic definition of Trigonias: Primitive, hornless, dolichocephalic, true rhinoceroses with functionally tetradactyl manus, known only from the Chadron

Formation (= Titanotherium Beds, Lower Oligocene) of Colorado, Nebraska, and South Dakota.[1] The nasals and premaxillaries are elongate, and the latter are closely appressed and may be more or less suturally connected. I^{1-2}_{1-2} C^{1-0}_{0-1}, P^{4}_{4}, M^{3}_{3}. Of the front teeth, only I^1 and I_2 are functionally important. P^1 is relatively large. In the more primitive members of the genus, the protoloph of P^2 has an unusually low connection with the ectoloph for a true rhinoceros, a situation suggesting *Hyrachyus*. P^4 is never fully molariform, the hypocone being principally attached to the protocone, and separated from the metaconule by a valley. M^3 may retain a trace of the posterior buttress. (See Wood, 1927, pp. 198–215, for additional data and discussion.)

Gregory and Cook's summary of the morphological divergences of the *Trigonias* Quarry material requires some modification (page 5). "This divergence runs all the way from a much more primitive construction than that found in *T. osborni* to complete molarization of all the pre-molars, advanced as far as the condition found in the upper Oligocene forms of the genus *Caenopus*." I should state the case as follows: This divergence runs from a primitive stage of *T. osborni* to virtually complete molarization of the second and third premolars and marked progress in the last, comparable to upper Middle Oligocene species of *Subhyracodon*. On page 5, by a misprint, *Trigonias* is defined as having none of the upper "molars" strictly molariform, when, of course, "premolars" is intended. I disagree slightly with the authors as to the relative primitiveness of the different stages of premolar evolution shown in their figure 5. Taking into account the general trends of rhinocerine evolution, I should arrange them in the following order (in relation to the characters shown in these figures only): K, C-diverging in one direction, then after K, on the main line, D, and F, then, a marked advance, E.

It will be observed that I group these specimens somewhat differently from Gregory and Cook. Another worker might handle them still differently; this is, however, the set of cubbyholes which seems to me to permit the most natural arrangement of the specimens. The divergences in possible viewpoints show the intergrading character of most of the material. In general, I prefer to take a position more conservative than that of Gregory and Cook, but less so than that of Matthew.

[1] Dal Piaz (1929) mentions *Trigonias ombonii* from Monteviale, Italy, of which the description is apparently to appear shortly. If, as seems almost certain, this name refers to the material which I saw in Padua in 1927, it has no significant relation to *Trigonias*, but belongs in *Epiaceratherium*.

Trigonias osborni osborni Lucas

Figures: Lucas, 1900, 1 and 2, (fig. 1 reproduced in Scott's "Land Mammals" fig. 177); Hatcher, 1901, Pl. I, figs. 1 and 2, Pls. II–IV; Troxell, 1921, p. 46, fig. 3; Cockerell, 1923, p. 275; Wood, 1927, figs. 20–28; Gregory and Cook, 1928, Pls. I and III.

Synonymy: *Trigonias osborni* Lucas, 1900; *Caenopus platycephalus nanolophus* Troxell, 1921; *Trigonias osborni figginsi* Gregory and Cook, 1928; *Trigonias osborni secundus* Gregory and Cook, 1928.

The characters of *T. osborni* have been fully discussed elsewhere (Wood, 1927). I disagree with Gregory and Cook that *T. nanolophus* (Troxell), Troxell, fig. 3, 1921, is probably a good species. It seems to me, as I indicated in 1927 (p. 213–214), to be almost identical with Lucas' type specimen of *T. osborni osborni*, allowing for the difference in the amount of wear.

The type of *Trigonias osborni figginsi* Gregory and Cook, Cat. No. 897-H, Colorado Museum (Gregory and Cook, Pl. I and IIIb) appears to be inseparable from the type of *Trigonias osborni* Lucas (Wood, 1927, figs. 20–21) and becomes, therefore, a synonym. The stated differences from Hatcher's referred specimens (Hatcher, Pl. I, II, and IV, and Wood, figs. 22–24) can be explained by crushing and extensive tooth wear. I^1, C^1 and P^{1-3} seem very similar to Lucas' type. The only difference observed is that the outer attachment of the protoloph of P^2 of "*figginsi*" seems lower, as the dentine areas of the protoloph and ectoloph are still separate. However, they would coalesce on further wear. Skull C (Cat. No. 881, Colorado Museum, Gregory and Cook, Pl. IVB), referred to *T. osborni figginsi*, seems to belong in *Trigonias hypostylus*.

The following Colorado Museum specimens seem to be definitely referable to *Trigonias osborni osborni*: Cat. Nos. 420, 421, 879, 888-E′, 892-H′, 897-H (type of *T. "figginsi"*), 955 (which, however, has some peculiar features), 1024 (cf., however, *T. precopei*), 1051, and 1052.

There is an unusually long sharp crista on the right P^3 (but not on the left P^3) of *T. osborni osborni*, Cat. No. 1050 R, reaching from the ectoloph across to the protoloph and forming a small basin, as in certain hyrachyids. This resemblance, of course, is entirely due to parallelism. Otherwise, this specimen is commonplace. Neither P^3 is quite molariform. Left P^3 has a fully developed metaloph, closely united with the protoloph. The hypocone of right P^3 is about equally connected with the protoloph and the metaconule.

A young individual, Cat. No. 422 (B), Colorado Museum, has more primitive P^2s than any other specimen of *Trigonias*, or, for that matter, than any other true rhinoceros which I have seen (fig. 2). It does not seem advisable to separate it, however, from the *T. osborni osborni* group. The second upper premolars have hardly advanced beyond the third and fourth, so that they suggest the condition in *Hyrachyus*. The connection between the ectoloph and protoloph of P^2 is very low and the median valley opens to the rear over the low wind-gap between the hypocone and the metaconule. The hypocone, although defined from the protocone by a deep internal groove, is essentially a portion of the protoloph. The tooth is slightly worn; previous to this wear, the tips of the protocone and hypocone would apparently have been slightly separated. Both of the P^3 and the right P^4 are in place. The left dP^4 had not yet been replaced. P^3 and P^4

are generally like P^2, except that the wind-gap is lower in P^2 than in P^2, and the median valley of P^4 is completely open to the rear. The hypocone is only slightly

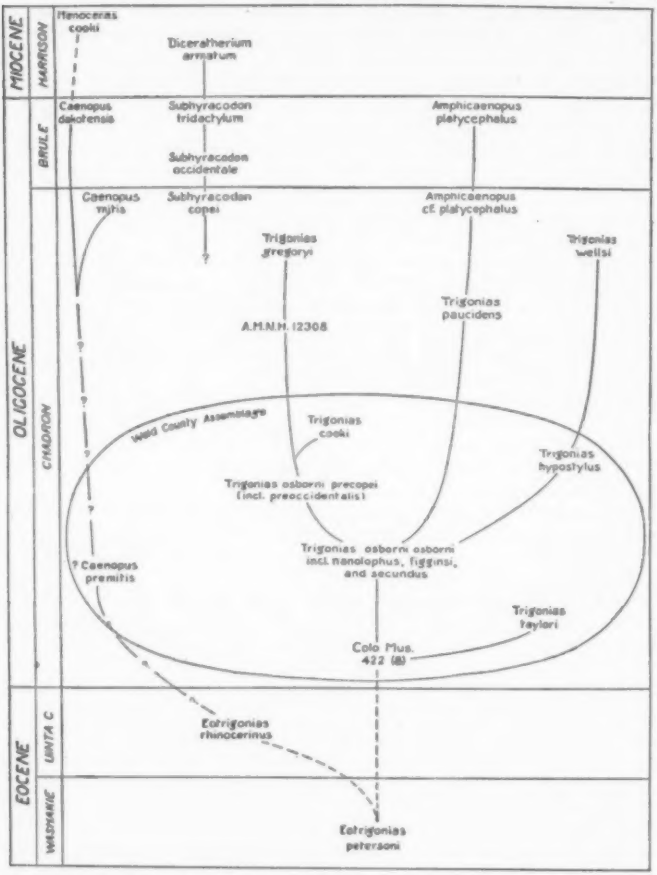

FIG. 1. Phylogenetic chart of the genus *Trigonias* and related American forms

defined in P^2 and not at all in P^4. On the right, P^4 and M^3 are cutting the gums; left M^3 had not yet erupted.

Cat. No. 1055 (W) Colorado Museum, appears to be a primitive member of *T. osborni osborni*, with certain peculiar features. Both of the P^2s have a wide gap

to the rear between the metaconule and the hypocone. Both of the P^3s are normal, and similar except for the hypostyle on left P^3; right dP^4 is not yet replaced. The left dP^4 has either a twinned metaconule, or a hypostyle misplaced to the front. Except as noted, hypostyles are not present. This individual shows some tendencies toward *Trigonias hypostylus*.

Cat. No. 421, Colorado Museum, appears to be referable to *T. osborni osborni*. Left P^2 is a little unusual, since the hypocone is transversely elongated, although its dentine is not yet quite confluent with that of the metaconule. Left P^3 is peculiar, since it has twinned metaconule and metacrista, connected at their tips and enclosing a small basin.

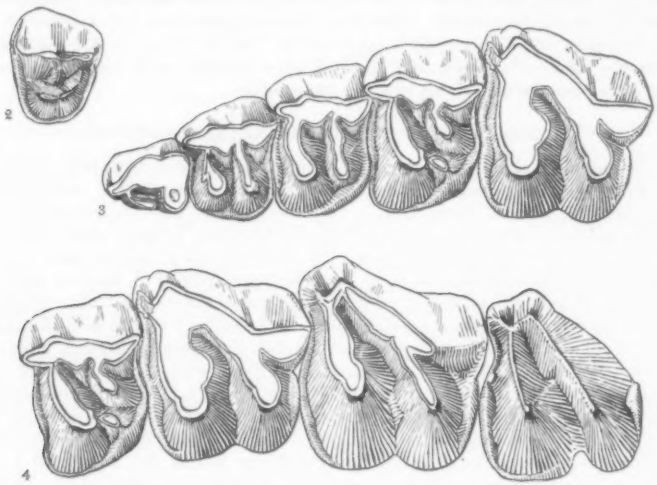

FIG. 2. Right P^2 of Cat. No. 422, B, Colorado Museum, *Trigonias osborni* cf. *osborni*, $\times\frac{2}{3}$.

FIG. 3. Left P^1–M^1 of holotype of *Trigonias cooki*, new species, Cat. No. 1053, U, Colorado Museum $\times\frac{2}{3}$.

FIG. 4. Left P^4–M^2 of holotype of *Trigonias cooki*, new species, Cat. No. 1053, U, Colorado Museum $\times\frac{2}{3}$.

Cat. No. 955, Colorado Museum, is a progressive variant of *T. osborni osborni*. It is a young individual, with dP^4 still in place. The protoloph and metaloph of P^1 are complete and nearly parallel, and accessory internal cuspules occur in front of the protoloph. P^2 is unworn and almost fully erupted. The protoloph and metaloph are fully separate, nearly down to the level of the cingulum. The metaloph seems to hook to the rear more than usual. The protoloph has almost no connection with the ectoloph. In P^3, the hypocone is defined from the protocone by a faint, internal groove only. The metaconule is widely separate from the hypocone, leaving a posterior opening to the median valley.

Cat. No. 1026, Colorado Museum, here regarded as referable to *T. osborni osborni*, has the transverse lophs of P^2 separate nearly to the level of the cingulum. The metaloph of right P^1 forms (with the protoloph) a nearly continuous antero-posterior ridge, not at all connected with the ectoloph. P^2 is very progressive for *T. osborni*; it is more progressive than in *T. osborni precopei*. The hypocone is as high as the protocone, well separated from it at the crown, and connected with the metaconule almost as much as with the protoloph, enclosing a V-shaped basin. The dP^4s had not yet been replaced. This specimen is quite progressive, but its features do not require taxonomic recognition. P^3 of this specimen follows alternative 3b in its metamorphosis (Wood, 1927, p. 238); that is, the hypocone joins the metaconule before it has separated from the protocone, completely enclosing the median valley. This is the course apparently followed by P^2 in the *Trigonias osborni* group, although P^2 of Cat. No. 421, Colorado Museum, suggests the alternative possibility that the hypocone may have been an isolated cusp for a time, before joining with the metaconule.

Trigonias osborni var. **secundus** Gregory and Cook

The authors make, here, for the first time, a much-needed distinction between the hypostyle, a separate independent cuspule, appearing in the post-fossete, and their "metacrista" (new term), a projection mediad from the metacone.

The holotype is Cat. No. 884-F, Colorado Museum, Gregory and Cook, Pl. IIIA. This variety seems very doubtfully distinct from *T. osborni osborni*. It might be used to indicate the more primitive specimens of *T. osborni*, with P^2 definitely premolariform, that is, with the hypocone connected with the protocone and partly separated from the metaconule. This is shown to be a doubtful basis for varietal distinction, however, by Cat. No. 1051-S, Colorado Museum, in which the right P^2 agrees with advanced specimens of *T. osborni osborni*, while the left P^2 agrees with *T. osborni secundus*. In Cat. No. 884 (F), Colorado Museum, the holotype of *T. osborni secundus*, the metaloph is the only transverse crest on P^1. The only sign of a protoloph is a basal cingulum in the right position to give rise to it. P^2 has the hypocone demarked from the protocone, but connected to it. The median valley escapes over a "wind-gap" between the metaconule and the protocone. In P^3 and P^4, the hypocone is less demarked, the metaconule is attached to the protocone, and the lowest point in the divide, in an unworn tooth, would probably have been between the metaconule and the hypocone. The left P^3 has an accessory cusp, probably an outwardly-displaced hypocone. Both P^4s have metacristae, the only distinctive subspecific character that could be considered definitely valid, since it is present on both sides. This hardly seems a sufficient basis to establish a new variety. The right P^4 has the hypocone attached only to the rear of the metaconule. This seems, at first glance, a very distinctive character, but with a little less wear it would appear as an isolated cusp, as in Cat. No. 12308, A.M.N.H., or, with a little more wear, every distinctive feature of the pattern would be obliterated. I do not feel that this variety can justifiably be established on this specimen; particularly in view of the character of Cat. No. 1051 (S), Colorado Museum, described below.

In Cat. No. 1051 (S), Colorado Museum, the median valleys of the right and the left P^{3-4} open to the rear, as in *T. osborni osborni*. In the right P^2, the transverse lophs are fully separate to below the level of the cingulum, so that the tooth

is molariform; in the left P^2, the hypocone, although a definite cusp, is attached to the protocone, and there is a "wind-gap" between the hypocone and metaconule. The left premolars had previously been covered with matrix so that their character had not been observed. The P^1s have two lophs, the protolophs much lower than the metalophs and looping around against them. On the whole the left P^2 could best be referred to *T. osborni secundus*, while the right P^2 resembles *T. osborni* or *T. precopei*. It would, then, seem reasonable to regard *T. osborni secundus* as being merely an aggregation of the more primitive individuals of *T. osborni osborni*. The Colorado Museum specimens of this general category are: Cat. Nos. 884 (F), the type; 422 (B), referred by Gregory and Cook to *T. figginsi*; 876 (M); 880; 951 (I); and 1051 (S), all of which intergrade with *T. osborni osborni*.

Trigonias osborni precopei Gregory and Cook

Gregory and Cook, 1928, Pl. VIIA.

Synonymy: *Trigonias precopei* Gregory and Cook, and *Trigonias preoccidentalis* Gregory and Cook. The holotype is Cat. No. 414, D, Colorado Museum (Gregory and Cook, Pl. VIIA). This form can only stand as, at most, a progressive variety of *T. osborni*, rather than as a distinct species. The lophs of P^2 are fully separate, as in some individuals of *T. osborni osborni*. The metaconules of P^3 and P^4 are a little more closely attached to the protocone than in *T. osborni osborni*. These characters make it legitimate to regard this form as a progressive phase of *T. osborni*. The resemblance to *Subhyracodon copei* in premolar pattern, observed by Gregory and Cook, is unquestionable, but the interpretation of this resemblance is another matter. Certainly, this is the only known form, whether of *Trigonias* or of anything else, that seems even faintly plausible as an immediate ancestor of *Subhyracodon* in general and *S. copei* in particular. On the other hand, it is materially larger than the earlier species of *Subhyracodon*, and retains the full *Trigonias* complement of front teeth, whereas the Lower Oligocene species of *Subhyracodon* have already completely lost I^3 and C_1, and frequently, C^1 also. The question whether *Trigonias osborni precopei* gave rise to *Subhyracodon copei* should be kept open until more data come to hand. I, personally, doubt that it did.

I am unable to regard *Trigonias preoccidentalis* Gregory and Cook (Gregory and Cook, Pl. VIB), based on Cat. No. 878, G, Colorado Museum, as a valid form. It seems to be a synonym of *T. osborni precopei*. The main differences are due to the greater amount of wear suffered by the type of *T. preoccidentalis*, for which, it seems to me, the authors do not allow sufficiently. If the type of *T. osborni precopei* were worn down, it would have an identical pattern. Cat. No. 1056, X, Colorado Museum, is just a shade less worn than Cat. No. 878, and shows exactly transitional patterns on the left P^3 and the right P^4 while the right P^3 and the left P^4 are identical with Cat. No. 878. Minor differences exist in size, in the attachment of the metaconule of P^4 to the protocone instead of to the hypocone, and in the partial interruption of the internal cingulum by the hypocone of P^3, but they hardly seem to require taxonomic recognition. In any case, this is not the ancestor of *Subhyracodon occidentale*, as the name would suggest, since the derivation of the latter from *S. copei* is adequately demonstrated (Wood, 1927

and 1929a). The individuals referable to *T. osborni precopei* are: Colorado Museum Cat. Nos. 414 (D), the type of *precopei*; 1026; 1056 (X); and 878 (G), the type of *preoccidentalis*.

Trigonias taylori Gregory and Cook

Gregory and Cook, 1928, Pls. II and VA.

The holotype is Cat. No. 1029 (K), Colorado Museum. Although the peculiarities of this skull may have been slightly accentuated by post-mortem crushing, this could only explain a minor part of its peculiar features. I should be tempted to consider this individual as an achondroplastic mutant, paralleling similar mutants observed in goldfish, bull-dogs, man, and the Austrian cave bears. It should be observed that it, as well as *T. wellsi* and *T. hypostylus*, are slightly less progressive, as to premolar metamorphosis, than the typical *T. osborni osborni*, and may have been derived from some slightly more primitive stage. *T. taylori* certainly deserves specific rank if it is regarded as a race, and not merely as an abnormal individual, since it is at once primitive in some features, and aberrant in others.

Trigonias hypostylus Gregory and Cook

Gregory and Cook, 1928, Pl. VB

The holotype is Cat. No. 886, J, Colorado Museum. The chief specific character is the presence of hypostyles on P^3 and P^4 (Gregory and Cook, Pl. VB). The transverse lophs of P^2, though distinct, unite well above the cingulum, as in Cat. Nos. 1054 (V) and 881 (C), referred to this species. The hypostyles of P^3 become confluent, after some wear, with the ectoloph; those of P^4 are still very distinct from the ectoloph. LP^3 has an accessory cusp between the metaconule and the protocone, occupying the posterior outlet of the median valley.

Skull C (Colorado Museum, Cat. No. 881), referred by Gregory and Cook to *T. osborni figginsi* (Pl. IVB), should be placed in *T. hypostylus*, chiefly because of its agreement with the type of the latter in the presence of hypostyles on P^3 and P^4. The two are close to the same size, and, in any case, every one of these Colorado specimens is within the probable range of specific variation in size of every other specimen, and hence their size characters are not especially significant. P^2 differs from the type in the fact that the protoloph trends more to the rear and is more closely connected to the metaloph. In P^3, the hypocone and metaconule are closer together and the hypostyle is a shade smaller than in the type. The hypostyle of the right P^4 is a high conical cusp. That of the left P^4 is crescentic, nearly connecting with the metastyle and metaconule, so that further wear would make it appear even more like a backwardly swinging metaconule than do P^{3-4} of Cat. No. 1054, V, Colorado Museum. The right P^3 has a small metaconule, the left P^3 a tiny one.

The exact character of a third specimen, probably referable to *T. hypostylus*, Cat. No. 1054, V, Colorado Museum, is in doubt, due to extreme wear. Hypostyles may have been present on both P^3s and on left P^4, or these may have been metacristae, or this appearance may have been due to the metaconule looping around all the way to the rear. This last is the case on the right P^4, which certainly did not have a hypostyle.

Another individual suggesting intergradation between *T. osborni* and *T. hypostylus* is Cat. No. 1055, W, Colorado Museum. A hypostyle is present on the left P^3. There are no hypostyles on the left P^2, or the right P^{2-3}. The left P^4 has what may be called either an accessory metaconule or a misplaced hypostyle.

Trigonias hypostylus is an ideal ancestor for *Trigonias wellsi* Wood. In view of the close general resemblance of *T. hypostylus* to *T. osborni*, and of the partly intergrading specimens described above, the two forms would appear to be closely related. On this basis, I now feel that I formerly gave *T. wellsi* somewhat too long a line of independent ancestry (Wood, 1927, fig. 1).

Trigonias cooki, new species (figs. 3 and 4)

The holotype is Cat. No. 1053, U, Colorado Museum (figs. 3 and 4). The name is given in recognition of the work done on fossil rhinoceroses by Mr. Harold J. Cook. The cheek teeth are very advanced for a member of the genus *Trigonias*—even more advanced than *Trigonias gregoryi*, although not nearly as large as the latter. Its closest resemblances are with *T. gregoryi*, of which it may be considered a collateral ancestor. The skull has about average proportions for this material. Such crushing as occurred was dorso-ventral. The right and the left P^1–M^3 are present, the premaxillaries and front teeth having been lost. P^1 is of normal type, with both transverse lophs looping to the rear, internally. P^2 and P^3 have parallel transverse lophs, fully formed, and separate down to the level of the cingulum. P^2 is very similar to P^2 of *T. gregoryi*, but P^3 is much more advanced so that this form seems to be barred from direct ancestry to *T. gregoryi*. The internal cingulum of P^2 is nearly interrupted by the protocone; the internal cingulum of P^3 is complete; that of P^4 is nearly interrupted by the hypocone. None of the cheek teeth have external cingula. M^{1-2} have no internal cingula. M^3 has a poorly marked internal cingulum on the protocone, and a strong posterior cingulum rising externally into a small cuspule. A faint depression and swell mark the position of the lost posterior buttress. P^4 has an oval hypocone attached to the posterior flank of the protocone, and separated from the metaconule by a wide valley, so that the median valley opens widely to the rear. The right P^4 has the inner tip of the metaconule incipiently twinned. The median valleys of M^{2-3} have wide "flood plains." The protocone of M^1 is well set off from the protoconule, both anteriorly and posteriorly. The protocone of M^2 is faintly defined anteriorly, and fairly well to the rear. That of M^3 is faintly defined to the rear, with only a bare trace anteriorly. The left M^3 has a small cuspule on the anterior cingulum, which is not represented on the right M^3.

Trigonias cooki, new species, Cat. No. 1053, U, Colorado Museum

	Right mm.	Left mm.
Nasals to occipital crest	465	464
Across zygomas	241	
Occiput, above condyles	112.5	113
Between P^2s	47.5	
Between M^3s	58.0	
P^1–M^3	203.5	203.0
P^2–M^3	184	184

	Right mm.	Left mm.
P^{1-4}	89.5	88
P^{2-4}	68	67
M^{1-3}	117	118
P^1, A-P		19.2
P^1, Tr		17
P^2, A-P	19.5	19.5
P^2, Tr. (across metaloph)	29	29
P^3, A-P	24.5	24
P^3, Tr (across protoloph)	34	34
P^4, A-P	24	23
P^4, Tr (across protoloph)	38.8	38.6
M^1, A-P	36.2	35
M^1, Tr (across protoloph)	42.0	43.2
M^2, A-P	42	42
M^2, Tr (across protoloph)	48	48.1
M^3, A-P	39.2	39
M^3, Tr (across protoloph)	43	44.2

? **Caenopus premitis** Gregory and Cook.

Gregory and Cook, 1928, Pl. IVA

The holotype is Cat. No. 1025, E, Colorado Museum, (Gregory and Cook, Pl. IVA). This last member of the Weld County group is a distinctive form, whatever its affinities. Gregory and Cook are doubtful whether it belongs in the genus *Caenopus* (*sensu strictu*) or in *Trigonias*, and suggest that it gave rise to *Caenopus mitis*. This specimen is intermediate between *Trigonias* and *Caenopus* (*sensu strictu*) in definable premolar characters, but is more like *Caenopus mitis*. It is intermediate between the two, in size. P^2 and P^4 are less progressive than in Caenopus mitis, P^3 is in the same evolutionary stage. The paratype of *Caenopus mitis* and the type of *?Caenopus premitis* are about equally worn, but the protoloph and metaloph are separate in P^2 of *C. mitis* and united in *?Caenopus premitis;* and in P^4 of *C. mitis* the transverse lophs are quite distinct, but much less so in *premitis*, and the "mure" of *premitis* is less marked. The molars are intermediate in character between *Trigonias* and *Caenopus;* for example, M^2 is intermediate in outline between the trapezoidal shape of *Trigonias* and the subrectangular shape of *Caenopus*. M^3 retains a trace of the posterior buttress. *?Caenopus premitis* may well be, as Gregory and Cook suggest, an intermediate stage between *Trigonias* and *Caenopus* (*sensu strictu*). The resemblances to *C. mitis* are certainly striking, but *?C. premitis* is materially larger (the length of P^{1-4} is 80 mm., as compared with 69.5), and the premolar internal cingula are much stronger. Until the discovery of further evidence, the alternatives of parallelism with *Caenopus* versus ancestral relationship to it, should be left open.

CONCLUSIONS

1. Most of the rhinoceros material from the Weld County quarry is closely interrelated. It appears to show the beginnings of later specia-

tion. The question as to just what taxonomic recognition should be given to the different strains has been answered in diametrically opposed fashion by Gregory and Cook, and by Matthew, without any serious difference of opinion as to the actual facts involved. I have taken a somewhat intermediate position, solely on the basis of convenience, and without any mystical views as to what constitutes a "real" species in paleontology. This view is expressed in diagrammatic form on the phylogenetic chart (fig. 1). One new species, *Trigonias cooki*, is described, and three other forms are reduced to synonymy.

2. Matthew (1931) apparently regards the genus *Trigonias* as ancestral to all other true rhinoceroses. This view seems unduly simplified. At the most, *Trigonias* may be directly ancestral to a very few European and to most American forms. Some of the evidence for this has already been published (Wood, 1927, 1929a, 1929b), and more will appear later. *Trigonias* is, however, the most primitive true rhinoceros which is fully documented.

3. Matthew's views as to the phylogeny of the rhinoceroses are interesting and suggestive, but they seem to be an over-simplification of the actual situation. In several respects, such as the miscellaneous and diverse group of European and American genera which he lumps as "*Caenopus*" (including *Epiaceratherium*!), he can hardly be correct. Discussion and criticism of his views in regard to the relationships of the later rhinoceroses is reserved for the future.

4. Stehlin has proved that the tusks of the European genus *Epiaceratherium* are not I^1 and I_2, but are probably $C\frac{1}{1}$. The doubt which he apparently feels as to the identity of the tusks of the American rhinoceroses is definitely negatived by the known *Trigonias* material. As the tusks of other true rhinoceroses are closely comparable morphologically with those of *Trigonias* and differ definitely from those of *Epiaceratherium*, the latter genus would seem to be the aberrant form. The Epiaceratheriinae should be considered a distinct subfamily, paralleling the Amynodontidae in their tusks, while remaining typically rhinocerotid in their cheek teeth and body structure.

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GENERAL NOTES

A PREGNANT WATER SHREW

On the morning of July 17, 1931, a water shrew (*Neosorex palustris navigator*) was captured among the cabins of University Camp a few yards from a small stream. University Camp is located about thirty miles from Boulder, Colorado, at an elevation of 9600 feet. During the day it ate grasshoppers, moths, ants, and flies. After being placed in a jar of water, where it swam and dived, it spent about fifteen minutes in vigorously scratching itself, at the end of which time it was almost dry. It died in the evening. Dissection showed it to be a female with eight embryos 2 cm. long and apparently nearly ready to be born.—KENNETH GORDON, *University of Colorado, Boulder, Colo.*

ANOTHER RECORD OF CRYPTOTIS PARVA FOR MICHIGAN

A specimen of *Cryptotis parva* taken at Ann Arbor, Washtenaw County, Michigan, on November 16, 1929 furnishes the ninth record of the occurrence of the species in the state. The specimen, with skin and skull, is in the writer's private collection.

The individual was trapped on the slope of an open grassy hillside in the "Arboretum," at the edge of Ann Arbor. The trapping station comprised the western exposure of the hillside, which was grown up to short grass. The specimen was taken about 50 feet from a low marshy area, which bounds the grass on the west. There had been much rain previous to the trapping and the ground was well soaked.

From this information, added to published accounts, the habitat of this species is grassy situations and, occasionally, damp woods. Other small mammals trapped in the same station were: *Blarina brevicauda talpoides*, *Microtus pennsylvanicus pennsylvanicus*, *Synaptomys cooperi cooperi*, *Peromyscus maniculatus bairdii*, *Zapus hudsonius hudsonius*, *Sylvilagus floridanus mearnsi*, and *Mephitis nigra*.—PHILIP M. BLOSSOM, *Museum of Zoology, Ann Arbor, Michigan.*

THE DISK-WINGED BAT (THYROPTERA) IN PANAMA

Since the disk-winged bats of the genus *Thyroptera* are not recorded from Panama in Goldman's "Mammals of Panama," it may be of interest to set on record the circumstances under which the two species now known from the Republic were taken.

G. M. Allen and T. Barbour (Bull. Mus. Comp. Zoöl., vol. 65, p. 271. 1923.) record *Thyroptera albiventer* from the Rio Jesusito, eastern Panama. "This little bat was caught with specimens of *Rhynchiscus* in the great, dry, curled up Heliconia leaves," (p. 272).

I took a specimen of the same form on Nov. 29, 1928, on the south shore of Barro Colorado Island. The animal was spending the day in the curled up leaf of some green plant, which had the form of a cornucopia, at about three feet from the ground. I tested the sucking power of the disks after the bat had been killed, and found that the disk of one thumb had sufficient suction to support the entire weight.

On August 10, 1923, in a similar plant, at the same distance above ground, eight

bats were found spending the day. The locality was near Gutierrez, at an elevation of about 4000 feet on the trail from the Chiriqui Lagoon to Boquete, in extreme western Panama. Four of them were taken and were described by Dr. G. M. Allen as *Thyroptera tricolor albiventer*. (Proc. New England Zoöl. Club, vol. 9, p. 1–2. Dec. 10, 1923.)

My own two findings of this extraordinary bat genus occurred in the course of searching for tree frogs, which f.equently spend the day in such plants. These reports from Panama would seem to indicate that *Thyroptera* roosts on smooth surfaces hanging by their disks rather than by their claws.—E. R. DUNN, *Haverford College, Pa.*

BATS ON THE COLORADO DESERT

Keyes Ranch, on the Colorado Desert in Riverside County, is in the tree yucca belt with a scattering of pinyon pines. December 29, 1930, we found some bats here under rather unusual circumstances. The owner of the ranch had formed a reservoir by throwing a levee across an intermittent desert stream bed. To catch fish, which he had planted in the lake, he had stretched a wire from one side to the other; from this, short lines with fish-hooks were suspended. Usually the hooks were in the water, but at this time they were several inches above the water because of the drought. The weather was cold and two or three inches of ice had formed over the surface. In this ice were embedded forty or more Mexican free-tailed bats. Some were entirely embedded; a few of those which were not had been partially eaten by predators. On separate fish-hooks were a California mastiff bat, a desert horned owl, and a Mexican free-tailed bat. All were caught by the wings.

The most obvious explanation of the presence of the bats on the hooks and in the ice is that they came down to the lake to get a drink. In skimming the surface of the ice, they might have been injured by the impact or, perhaps, they were captured by the slush which would have covered the ice in the early evening. The mastiff bat was evidently impaled as he brushed by the hook in flight. By people who have observed them, mastiff bats are reported to be high flyers. This coupled with the fact that there was no other standing water for miles around indicates strongly that it was attracted by water.—BERRY CAMPBELL, *Monrovia, California.*

FUR-PICKING IN MONKEYS AS AN ACT OF ADORNMENT

Some crustaceans decorate themselves by attaching objects to their shells and some birds alter their plumage in a manner to affect their appearance. Captive monkeys and apes are known to use various objects for self decoration. These decorative services, according to reports, are always self-rendered.

In the case of two monkeys, a female *Macaca irus* (*"M. cynomologus"*) and a male *M. mulatta* (*"M. rhesus"*), which the writer observed for several years, the fur-picking activity of the male appeared to serve not merely in cleansing the skin of the female of foreign substances, but also to include the modifying of her appearance to suit his taste. On two occasions, when the two animals were separated for several weeks, the eyebrows and cheek tufts of the female trew sufficiently long to alter her appearance definitely. Both times when the pair were reunited the male immediately proceeded to pull out part of the hairs of the eyebrows of the

female and to bite off others which were unusually long. One by one he pulled out practically all of the long hairs of the cheek tufts, greatly changing the female's appearance. During this hair-pulling activity, the male frequently leaned back and surveyed the female as if evaluating the results. This is the first recorded instance, to my knowledge, of one animal's appearing to contribute to the adornment of another.—O. L. TINKLEPAUGH, *Laboratories of Comparative Psychobiology of Yale University.*

A DEFINITE LOCALITY RECORD FOR LIOMYS SALVINI NIGRESCENS (THOMAS)

Three specimens of *Liomys salvini nigrescens* (Thomas), collected by Austin Smith, have been received at the University of Michigan, Museum of Zoology. These specimens, from Tempate, Costa Rica, represent the first definite locality records of this species, and are also the first specimens received in any American museum. The type locality of this form is given as Costa Rica. Tempate is in the province of Guanacaste, about ten miles from the Pacific Coast. These specimens were taken in December, 1930, in bushy pasture land at an altitude of one hundred feet. The measurements of two adult females and one adult male are as follows: Total length, 228, 230, 252 mm.; tail vertebrae, 121, 121, 130 mm.; hind foot, 27, 26, 29 mm.—WILLIAM P. HARRIS, JR., *University of Michigan, Museum of Zoology.*

WESTERN EXTENSION OF RANGE OF MICRODIPODOPS POLIONOTUS

The Mono Kangaroo Mouse (*Microdipodops polionotus*, Grinnell), heretofore has been taken at only Benton Station, Mono County, California, the type locality, and points east along the base of the White Mountains. It may be worthy of record, therefore, that on May 7, 1931, Mr. Geo. G. Cantwell, of the Los Angeles Museum, and the writer secured an adult pair of *Microdipodops polionotus* at Taylor Valley, 25 miles west of Benton Station, Mono County, California at an altitude of 7000 feet. The specimens measure as follows; No. 2538, Los Angeles, Mus., ♂ ad., May 7, 1931, total length 152 mm., tail 80 mm., hind foot 23 mm., collected by G. G. Cantwell. No. 1139, collection of Jack C. von Bloeker, Jr., ♀ ad., May 7, 1931, total length 149 mm., tail 82 mm., hind foot 22 mm., ear: 10 mm. The writer is indebted to Dr. Grinnell, Museum of Vertebrate Zoology, Berkeley, California, for confirmation of his identification of the specimens.—JACK C. VON BLOEKER, JR., *Los Angeles Museum, Exposition Park, Los Angeles, California.*

EXTENSION OF RANGE OF PEROGNATHUS PACIFICUS

Recently the writer "rediscovered" *Perognathus pacificus* at the type locality and, with the help of Mr. George G. Cantwell of the Los Angeles Museum, secured forty-four topo-type specimens, as detailed on earlier pages of this number. While enroute home to Los Angeles from the type locality on July 31, 1931, a close watch was kept along the roadside for localities suitable for colonies of these small pocket-mice. One large field near Oceanside and two small fields near San Onofre were located where it seemed likely, from the small holes, earth mounds, and similar signs peculiar to small pocket-mice, that we might be reasonably sure of obtaining additional specimens of *pacificus*. As it was necessary for us to return at once to Los Angeles, we marked the fields by tying rags to the fences, resolving

to return in the near future. A return was made to Oceanside on August 8th, and traps were set near San Onofre and near the mouth of the Santa Margarita River. The following morning we found a catch of fourteen *Perognathus pacificus* and eleven *Perognathus californicus femoralis* in our Santa Margarita River traps; one *P. pacificus* and one *Peromyscus maniculatus gambelii* in our traps two miles east of San Onofre; and one *P. pacificus* and two *Reithrodontomys megalotis longicaudus* in our traps at San Onofre. Telephone Weed, *Heterotheca grandiflora*, was the principal associational plant in all the fields. The two localities, Santa Margarita River and San Onofre, are, respectively, fifty-five and seventy miles north, by road, from the type locality of *Perognathus pacificus*.—JACK C. VON BLOEKER, JR., Los Angeles Museum, Exposition Park, Los Angeles, California.

NOTES ON SOME COLORADO WOOD RATS

Recent examination of a small series of wood rats from southern Colorado in the collection of the Colorado Museum has brought to light some interesting data concerning the range of the several forms, one of which is here recorded as an addition to the state mammal list.

Neotoma mexicana fallax (Merriam). Two individuals from Furnace Canyon, western Baca Co., Colorado, represent the extreme eastern limit of this widely distributed form. One was secured in an abandoned woodpecker excavation 20 feet up in an oak tree, growing on the canyon floor. The other was trapped in the recesses of a rocky cavern.

While no specimens were taken in contiguous areas of the Oklahoma panhandle, there is reason to believe that this rat occurs there also.

Neotoma albigula warreni (Merriam). Two immature males, one from Trinchera, Las Animas Co., and the other from near the junction of the Huerfano and Cucharas Rivers, Pueblo Co., Colorado, are the most western and northern records at present available. However, there is abundant evidence to suggest that *warreni* ranges throughout much of the adjoining pinyon and cedar region, northward to the vicinity of Pueblo. The specimen from Trinchera was taken with a small series of *N. m. fallax*, which is seemingly the dominant species in that locality.

Neotoma albigula albigula Hartley. A sub-adult and an adult male; one from Bondad, La Plata Co., and the other from Four Corners, Montezuma Co., Colorado, are the first recognized individuals of *albigula* to be taken in the state, and are from localities that materially extend the known range of the race.

These two specimens differ in important features from several topotypes kindly loaned for comparison by the Museum of Vertebrate Zoology, and may represent a small unnamed northern race. However, in the absence of more comprehensive material, no attempt is now made to settle this latter point. In coloration the two specimens, both taken in June, agree almost exactly with topotypes taken in February, but are very different from June specimens from Carr's Ranch in the Sierra Ancha, and from the Santa Rita Mountains, Arizona. In size, they are much inferior, averaging: Total length, 304.5 (290–319) mm.; tail vertebrae, 138 (128–148) mm.; hind foot, 31 mm. Cranially, the Colorado specimens are smaller, but with relatively heavier and larger molar series.—F. W. MILLER, *Colorado Museum of Natural History*.

BARBLESS QUILLS OF PORCUPINE

In the August issue appears an observation from Lawrence Kilham in regard to the killing of a pregnant porcupine and finding quills one-half inch in length on the offspring not yet born. Mr. Kilham sets the time as May 26 and the place as Tamworth, New Hampshire.

In my book, The Basis of Breeding, published in 1928, I reported a similar experience which I had in company with Dr. Stanley Ball, Curator of the Peabody Museum at Yale University, at Goshen, Massachusetts, on Good Friday, 1927. We treed a pregnant porcupine with a coon dog that had been trained not to attack a porcupine. We shot and opened her and found the young one to have long black hair and quills about one-quarter of an inch in length. It was quite lively and we brought it back to New Haven, but it soon died. It is now in the Peabody Museum. The quills had no barbs. A head first presentation at parturition would seem essential to the well being and perpetuation of the porcupine.

It may be of interest to note that there is a wide variation of the number of barbs on the quills of different porcupines. I have killed several which had perfectly smooth quills, while others had the barbed areas on the quills abnormally extended.—LEON F. WHITNEY, *New Haven, Conn.*

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COMMENT AND NEWS

INTRODUCTION OF FOREIGN ANIMALS

On December 5, 1929, the Linnean Society of London unanimously adopted the following resolution:

"That this Meeting deprecates all attempts to introduce and naturalise wild animals or plants in countries where they are not native, unless such introduction is urgently needed for economic reasons, and until a thorough study has been made of the local conditions and of the results that are likely to follow."

The subject was brought to the notice of the Society in connection with the proposed introduction of Black Buck from India into Ceylon.—Extracted from Proceedings of the Linnean Society of London, 142nd session, Jan., 1931, pp. 17–20.

DAVID STARR JORDAN

David Starr Jordan, educator, author, naturalist, advocate of peace, dean of American ichthyologists, and charter member of the American Society of Mammalogists, died at Palo Alto, California, on September 19, 1931. He was born on a farm near Gainesville, N. Y., on January 19, 1851, the son of Huldah Lake (Hawley) and Hiram Jordan. Jordan graduated from Cornell University in 1872 with the degree of M.S., and continuing his studies received an M.D. from Indiana Medical College in 1875, and a Ph.D. from Butler University in 1878. Dr. Jordan was also granted honorary degrees by Cornell, Johns Hopkins, Indiana, California, and Western Reserve universities, and by Illinois College. Beginning with his appointment as instructor of botany at Cornell (1871–1872) and during the period when he held the professorship of natural history at Butler University (1875–1879), Jordan's interests turned to the broader field of general biology and resulted in the publication of a "Manual of Vertebrate Animals of Northern United States (1876)," which has passed through thirteen successive editions. This has had a great influence in arousing interest in mammals among university students and has afforded assistance to thousands of others interested in our vertebrates. Dr. Jordan accepted the position of professor of zoology (1879–1885) and subsequently became president (1885–1891) of Indiana University. In 1891, he was called to the newly organized Stanford University as president and held that post until 1913; he was chancellor of the same institution from 1913 to 1916, and emeritus until the time of his death.

The study of fishes was a subject of absorbing interest to Dr. Jordan throughout his life and led him to collect and study the fish fauna of every state in the Union, Canada, Alaska, the Hawaiian Islands, as well as many foreign countries. Included among his long list of important contributions to ichthyology are the monumental work on "Fishes of North and Middle America (with B. W. Evermann, 1896–1900)," "The Genera of Fishes (1917–1920)," and "A Classification of Fishes (1923)."

JAMES WILLIAMS GIDLEY

James Williams Gidley, a charter member and former treasurer of the American Society of Mammalogists (1921–1922), died in Washington, D. C., on September

26, 1931, after an illness of several months. Dr. Gidley was born on January 7 1866, at Springwater, Winneshiek County, Iowa, the son of Quaker parents, Rebecca Penrose (Williams) and Isaac Mosier Gidley. His early education was limited to local Iowa public schools; he received the degrees of B.S. from Princeton in 1898, of M.S. from the same institution in 1901, and of Ph.D. from George Washington University in 1922. Following his appointment on the staff of the American Museum of Natural History in 1899, his first professional work in vertebrate paleontology was directed toward the enlargement of the collections of Miocene, Pliocene, and Pleistocene mammals. In 1901, he was placed in charge of all field explorations for fossil horses under the Whitney Fund. On February 15, 1905, Gidley was appointed preparator in the department of geology, United States National Museum. On November 1, 1907, he was promoted to the post of custodian of the collection of fossil mammals, and on July 20, 1911 he became assistant curator of fossil mammals, a position that he held until his death.

Some of the more important contributions to vertebrate paleonotology by Dr. Gidley are his articles on "Evidence bearing on tooth cusp development (1906)," "Revision of Miocene and Pliocene Equidae of North America (1907)," a series of papers on fossil mammals from the Cumberland Cave deposit (1913–1920), "Synopsis of supergeneric groups of rodents (with G. S. Miller, Jr., 1918)," and "Paleocene Primates of the Fort Union (1923)." He also contributed the material on fossil mammals for a volume of the Smithsonian Scientific Series now in press.

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